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of the
World's Dairy Congress

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SESSION 15. CONTROL OF THE QUALITY OF MANUFACTURED PRODUCTS.

Chairman, GEORGE L. FLANDERS, assistant commissioner and counsel, Department of Farms and Markets of the State of New York.

Secretary, L. S. CORBETT, head of the department of animal industry, University of Maine.

Y. W. C. A. ASSEMBLY HALL,
Syracuse, N. Y., Monday, October 8, 1923—9.30 a. m.

Chairman FLANDERS. The meeting will please come to order.

The first paper on the program this morning is "Governmental control of butter and cheese in Denmark," which is to be presented by Mr. S. Sørensen, agricultural adviser to the Danish Government, Washington, D. C. It gives me great pleasure to introduce to you Mr. Sørensen. [Applause.]

GOVERNMENTAL CONTROL OF BUTTER AND CHEESE IN DENMARK.

SØREN SØRENSEN, agricultural adviser to the Danish Government, Washington, D. C.

The Danish dairy industry is well known to the world, its co-operative system, technical efficiency, output, and quality of butter having attracted much attention in foreign countries. The international importance of this industry can be measured by the fact that Danish Lur brand butter comprises about one-third of the world's market supply. The prominent position of the Danish dairy industry is mainly due to close cooperation among producers, scientific experts, and the Government through the Department of Agriculture.

1. BUTTER CONTROL.

The present governmental activities grew out of a voluntary movement among the farmers to establish a national brand for the protection of Danish butter against unfair competition from other countries. Several cases of adulterated butter or butter from other countries being sold as "Danish butter," were proved before the courts in England.

In the nineties an attempt was made to have legislation passed introducing a national brand. This was unsuccessful. The producers, however, did not give up their fight. In 1900 some of the creameries founded a voluntary association, the Danish Butter Mark Society, which adopted the Lur brand as a collective mark for all butter exported by its members. The Lur brand consists of two pairs of "lurs" or trumpets, used by Scandinavian vikings during the bronze age. The Butter Mark Society had a great suc-

cess, and within a few years nearly all of the creameries had voluntarily become members and adopted the Lur brand.

A new action for legislation was started, and in 1906 a law was passed making the Lur brand compulsory for all butter exported from Denmark, and furthermore prescribing that all imported butter must be marked "Imported" and kept in the original package until sold to the retailer.

From experience gained during the first few years, it was found desirable to increase the efficiency of the legislation, and a new law was passed in 1911, giving the Minister of Agriculture power to control, not only the national brand, but also to a certain degree the quality of the butter. This law and the special regulations issued by the Department of Agriculture require that all butter bearing the Lur brand:

1. Must be prepared from Pasteurized cream. (The temperature to be not less than 80° Cel. or 176° F., controlled by the Storch test.)
2. Must not contain more than 16 per cent water.
3. Must contain no other preservatives than common salt.
4. Must not contain anilin color.
5. Must not be adulterated.
6. Must be up to a certain standard of quality.



FIG. 1.—Lur brand used on Danish export butter.

A few remarks may be necessary to further explain the requirements under Nos. 5 and 6.

Adulteration is regarded as a very serious violation of the law and is punishable by imprisonment without the option of a fine.

Denmark was the first country to pass legislation regulating the trade in margarin, the first law dating from 1885 and the present from 1907. All margarin must contain sesame oil, which is recognizable by a simple color reaction. Thousands of samples of butter and margarin are annually analyzed to see that no adulteration takes place. Furthermore, the manufacture of and the trade in margarin are under special Government control.

The control of the quality of Lur-branded butter is carried out as follows: Creameries accepted for control are under obligation to send whenever requested an already packed cask of butter to the State experiment laboratory in Copenhagen. This is paid for at the current price. The butter is kept in the laboratory and is not judged until about the time it would have reached the purchaser abroad. The judging is done by three groups of judges, each group comprising two butter merchants and one dairy representative.

Each judge must specify the faults he finds with the butter, and the results of the judging are communicated to the creamery for its guidance. Not only the quality of the butter, but also its apparent moisture, is examined, as well as packing and quality of wood and parchment paper. If the quality is not up to standard, another cask is called for, and if the quality of this is no better the manager is advised to call in the Government dairy expert for the district. Some time is allowed in which to find and remove the cause of the faulty quality, but if the butter remains unsatisfactory the creamery is deprived of the right to use the Lur brand, and its products can not be exported. The creamery may later succeed in improving the quality, when it will again be accepted for control and receive the right to use the Lur brand.

In compliance with the law and regulations, any creamery wishing to export butter must notify the local police, who will ask the proper authorities to investigate the facilities of the creamery and decide whether or not it can obtain the right to use the Lur brand. If the creamery is accepted, its entire production must be marked with the Lur brand. This is applied to two opposite staves of the casks, or two ends of the boxes, and in addition paper labels, so-called control labels, bearing the Lur brand are to be placed on the top and the bottom surface of the butter.

The Lur-branded staves and the control labels are manufactured by a licensed firm under special control of the Department of Agriculture; reproduction of the brand by others is prohibited by law. The Lur brand articles are delivered to the creameries by order of the department officials, and the staves and labels are numbered according to a secret system, enabling the Government inspectors to identify the butter until it has reached the first receiver abroad.

It will be understood from these facts that Lur-branded butter is guaranteed by the Government to be a genuine Danish product, free from danger of contamination by tuberculosis and other contagious diseases, and that the commercial quality is up to a certain standard, the water content not over 16 per cent, etc.

The law is administered by the Department of Agriculture through a staff of experienced inspectors. Thousands of samples are taken annually in creameries, warehouses, butter stores, etc., to see that all requirements are fulfilled. Heavy fines are imposed for violating the law; and, in addition, the butter will be confiscated if the water content is too high.

In 1922 nearly 1,600 creameries were under Government control, exporting approximately 96,000,000 kilograms (96,000 tons) of butter.

The Lur brand has been registered in several countries, England, Germany, Newfoundland, Australia, Portugal, Sweden, Switzerland, and the Netherlands, and it is expected to be soon registered in Belgium and Poland.

The laws of various countries do not protect collective trade-marks. At the international conference in Washington in 1911 for the revision of the International Convention for the Protection of Industrial Property, the contracting powers undertook to provide for the registration and protection of such trade-marks. In 1913 a law to that effect was passed in Denmark, and in 1912 the President of the

United States, in a message to Congress, recommended the passage of a corresponding law. Pending the passage of such legislation, however, the Lur brand is not without protection, as the laws regarding unfair competition, Acts of Congress of September 26, 1914, section 5, and April 10, 1918, section 4, are supposed to protect the Lur brand against unauthorized use.

2. CHEESE CONTROL.

The cheese industry has gained considerable importance during the last few years, the export in 1921 being more than 12,000,000 kilograms (12,000 tons). This development made it desirable to establish Government control of the manufacture and export. A law was drafted in close cooperation with the dairy organizations and passed March 1, 1921, authorizing the Minister of Agriculture to issue export regulations and to prescribe the fat and water contents and the marking of the different kinds of cheese. The regulations prescribe the following standard classes for hard and soft cheese:

	Minimum content of fat in dry matter.	Maximum content of water.
Hard cheese:	<i>Per cent.</i>	<i>Per cent.</i>
No. 1.....	45	50
No. 2.....	30	54
No. 3.....	20	57
No. 4.....	10	59
No. 5 (skim-milk cheese).....		60
Soft cheese:		
No. 6.....	45	60
No. 7.....	30	60
No. 8.....	20	60

Special types have to be of a certain class; Emmental and Cheddar must always be of class 1, Gouda and Edam of either class 1, 2, or 3, and so forth. Roquefort must contain at least 50 per cent fat in the total dry matter and not more than 52 per cent water.

All creameries making cheese for sale must notify the Government inspector, from whom they will receive a number which, together with the number of the class to which the cheese belongs, must be stamped directly on the hard cheese and on the packing material of the soft cheese. Inspectors visit the creameries to take samples and insure that regulations are complied with. The regulations may be subject to modification as experience is gained. In 1922, 675 creameries were under Government control, and the law has already proved of service to the cheese industry.

The Government control of butter and cheese may be improved upon, but it has hitherto been of great service to the whole dairy industry, and has helped to give the Danish dairy products a good reputation on the world market.

Chairman FLANDERS. Ladies and gentlemen, you have heard the paper presented by Mr. Sørensen. You have a few minutes at your disposal if you wish to ask any questions or discuss the paper.

Mr. M. MORTENSEN (Iowa State College, Ames, Iowa). I should like to know. Mr. Sørensen, if there are any creameries in Denmark at

the present time not using the Lur mark; and if so, would such a creamery be able to dispose of its butter, and where would the demand for it be? We in this country are quite interested in knowing something about it.

Mr. SØRENSEN. I am not able to tell you how many, but I know there are a few creameries which are not allowed to use the Lur brand. They will have to dispose of their butter on the home market, and, of course, they will always get a lower price than they could get through exporting it. You see quite a few creameries supply cities with butter and milk. Sometimes they have a surplus of milk which is not the best quality. Quite a few of these have not been allowed to use the Lur brand, and, of course, they have to dispose of their butter in the home market.

Mr. MORTENSEN. Are there any of the cooperative creameries in Denmark that are not permitted to use the Lur brand?

Mr. SØRENSEN. I am not able to say definitely as to that. Sometimes there are quite a few deprived of this right and other times there are very few. The control is going on all the time. I know quite a few of the cooperative creameries have been deprived of the right to use the Lur brand, but it varies from year to year, month to month, and I am not able to tell you the number. I had not thought of that, or I could have gotten the statistics on it.

Chairman FLANDERS. Are there any others who wish to ask Mr. Sørensen any questions? If not, we will take up the next paper on the program.

The next paper is entitled, "Butter control," and will be presented by Dr. A. J. Swaving, chief of the dairy division, Ministry of Home Affairs and of Agriculture, Holland. [Applause.]

BUTTER CONTROL.

A. J. SWAVING, Ph. D., inspector of dairying, chief of dairy division of the general direction of agriculture, Ministry of Home Affairs and of Agriculture, The Hague.

The Dutch control may be considered as an expression of the personal will of the manufacturers of pure butter to give guaranties as to the genuineness and purity of their products and to protect them against substitutes of butter mixed with margarin.

The butter control instituted since 1905, under Government supervision, guarantees that the butter coming from factories affiliated with the Dutch butter control is a pure product, made from cow's milk, without any addition of foreign fats, and with a water percentage below 16 per cent.

The affiliated members pledge themselves, of their own free will, to observe the rigorous control regulations and the additional rules on the strength of which the Government control marks are distributed.

They are subject to the supervision of the Government dairy inspection service instituted by the Government.

By means of a regular examination of the butter made in the affiliated factories, numerous data have been obtained concerning the composition of the butter in the different seasons in the different parts of the country. These data, viz, concerning the agreement of the

Reichert-Meissl-Wollny number with the refraction number, were collected at the Government dairy station at Leyden. The evidence of the genuineness of the controlled butter is based in the butter control on the agreement which must exist between the R. M. W. number in the sample of the butter examined, which has left the factory, and the R. M. W. number which was ascertained at the time of the making of the butter in the same factory.

This evidence can at all times be produced by means of the above-mentioned Government butter marks and of the registers kept for this purpose at the Government dairy station at Leyden (which distributes the Government butter marks to the butter-control stations), by the control stations (which deliver those marks to the persons affiliated to them), and by the affiliated members themselves, who must note down every day the numbers of the marks used by them and of the quantities of butter supplied with these marks.

These Government marks contain, to the left, a capital letter indicating the butter-control station that issued the mark paper; to the right, a capital letter is found indicating one of the five sizes of the



FIG. 1.—Dutch Government butter mark.

marks denoting the five different quantities for which the marks may be used, and one or more series of letters and a consecutive number. By means of these indications the origin of the butter and consequently the date of the making, and of the composition of the butter, also, can be traced with accuracy.

The Dutch Government butter mark is no mark of quality, but exclusively guarantees the genuineness and the purity of the controlled butter and that the water percentage in the butter is lower than 16 per cent. The butter act prescribes, however, that the butter must contain at least 80 per cent fat coming exclusively from milk.

A number of other butter-exporting countries, viz, Denmark, Sweden, Finland, Livonia, Esthonia, Ireland, New Zealand, Australia, United States of America, and Canada, by means of the control instituted by them and the legal prescriptions which are in force in them, guarantee their purchasers the genuineness and purity of the quality of their products.

Denmark.—In March, 1906, the "Lur mark" for Danish butter was instituted, consisting of an impression, in blue color, of the picture of four long old Scandinavian horns, with the words Dansk Smor (Danish butter) with a star and a number, on light-blue paper.

The number indicates the factory from which the butter comes. This mark must be pasted on the outside of the packing of the butter as well as on the two control certificates which are added to the butter coming from the factories affiliated to the Danish butter control.

A royal decree of April, 1911, moreover, stipulates that the butter shall not contain more than 16 per cent of water, while the addition of antiseptic ingredients with the exception of salt is prohibited. The cream from which the butter is made must be Pasteurized at 80° C. at least.



FIG. 2.—Danish Lur brand.

The supervision of the observance of the control regulations has been intrusted to the customs, to the police, and to the inspectors of the butter control, who have free access to all places where butter is made or stored. No butter may be exported but that which is provided with the Lur mark.

Sweden.—A butter control like that in Denmark has not yet been put into practice in Sweden.

In 1905 the "Rune mark" was instituted as a kind of quality mark for the best Swedish export butter. This mark consists of an inside figure with two heads of animals and the words "Choicest



FIG. 3.—Swedish Rune brand.

Swedish butter" at the top; in the center, to the left and right of the heads, "Rune brand," and under them in small letters "Registered and guaranteed pure" and "Without any preservative other than salt," printed in red ink on thin paper, which is put on the butter itself and, besides, burnt into the butter packing. In 1911, it was determined that this mark should be used exclusively for export butter meeting the following demands:

1. The cream from which the butter is made shall be Pasteurized at 80° C. at least.
2. The water percentage of the butter shall not exceed 16 per cent.
3. The butter shall have sufficient solidity.

4. The butter must have scored a certain number of points at the official examination.

Under the royal decree of December 15, 1922, no butter may be exported except in tubs provided either with the Rune mark prescribed for the Swedish butter control, or with a mark burnt into the outside of the tub or fixed in any other durable manner, stating that the butter is not authorized to bear the first-mentioned mark.

Finland.—In January, 1913, a compulsory control was instituted for all Finnish export butter, for which a control station was established at Hango, where all export butter was tested for determining the quality. The dairy factories which export regularly and are entered in the control must pledge themselves to the Government to use no other control marks but those which are furnished them by the Government. They must be observant of the rules given with regard to the making of butter: they may use no preservatives but salt, and the water percentage in the butter may amount to no more than 16 per cent unless it is unsalted butter, which may contain 18 per cent of water. Moreover, they must give the supervising officials all information required. The export butter in every dairy factory is examined every week with regard to purity, water percentage, and quality.

On April 8, 1913, marks were granted for the Finnish export butter:

1. For export butter a mark bearing the words "Pure Finnish butter, Tarkast, under Government control," printed in black letters on thin paper (5 by 8 centimeters) pasted directly on the butter (white paper) and also on the lid of the tub (red paper). The letters and ciphers indicate the year and the dairy factory. (Fig. 4, *a.*)

Finnish Tarkast brands.



a.



b.



c.

FIG. 4.—Finnish Tarkast brands.—(a) For export butter under Government control. (b) Additional mark for butter of first quality. (c) For export butter not under Government control.

2. The butter marked as first class by reason of the weekly compulsory control is further provided with a mark of quality, consisting of the picture of three butterbores with the superscription: Finnish Suomi Butter, as shown in Figure 4, *b*.

3. To exporters of small quantities, not affiliated with the control, a tax mark is given after examination. This mark bears the superscription: "Hango, Tarkast, Hanko." (Fig. 4, *c*.)

Livonia.—In October, 1922, a system of butter control was introduced in the new country of Livonia. Butter exporters (dairy factories) must be registered at the Department of Agriculture;



FIG. 5.—Livonian Government butter mark.

they pay the charges of the compulsory examination as to the purity, quality, and water percentage. The butter is divided into three classes: Class 1 is exempt from export duties; class 2 must pay export duties; class 3 is not permitted to be exported.

For the packing of butter of class 1, a label is used on which is printed in red letters "A. No. — Tirs Latvijas Sviests control. Rīga, Latvia. Pure Latvian butter" and on which a stamp is found in blue ink, "under Government control."

The packing of class 2 is provided with a label on which is printed in black letters: "Kontrolets A. No. — controlled," and besides with the above-mentioned impression of the Government stamp.

Esthonia.—No butter may be exported but that which is made in registered factories from cream Pasteurized at 80° C. at least and is provided with the Esthonian mark.

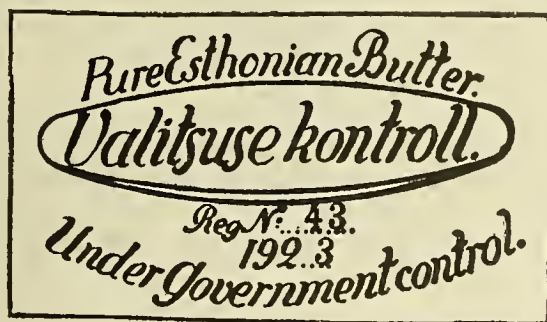


FIG. 6.—Esthonian Government butter mark.

This mark is printed in black letters on thin paper pasted directly on the butter (white paper) and also on the lid of the tub (red paper). It consists of the words: "Pure Esthonian butter. Valitsuse Kontroll. Reg. No. — 1923, under Government control."

Ireland.—In 1910 the "Irish Cooperative Creamery Butter Control" was established, to which only those factories are affiliated the

arrangement and working of which meet the requirements of the control system; the members are bound to fulfill the rules under supervision of the committee of control.

The butter made under control shall contain no fat but that coming from cow's milk, while the percentage of water may not exceed 16 per cent. As butter mark, a registered circular trade-mark is used with the superscription: "Irish cooperative creamery butter control, established 1910."



FIG. 7.—Irish cooperative creamery brand.

At the general assembly of the Irish Dairy Producers' Association, held in February, 1922, a compulsory official mark for all export butter was emphatically insisted on.

United States of America.—In several States, such as Minnesota, Iowa, Michigan, etc., a control system is established, by which trade-marks are distributed. It is, properly speaking, an examination as to quality, with a system of points aiming at the improvement of the quality of the butter.

Conformably to the provisions of the food-products inspection law, export butter is examined by the proper officials, but only at the request of exporters. In accordance with the official standards, the butter may contain no more than 16 per cent of water and no less than 80 per cent of butterfat; no other fatty substances may be found in the butter but those coming from milk.

Canada.—Here, too, a system of butter examination as to quality is established. Examination of export butter is not compulsory. In accordance with the regulations, made by order in council, butter may contain no other fat but that coming from milk or cream; the water percentage may not be higher than 16 per cent, and the fat percentage no less than 80 per cent.

New Zealand.—Here exists a compulsory examination as to quality, to which all export butter is submitted. In accordance with the regulations bearing upon this matter, which are based on the dairy produce act and regulations for butter and cheese, the butter after examination rests in the hands of the Government, which forwards it according to the directions of the owner. The same rules are in force as those mentioned below for Australia.

Australia.—In the Commonwealth of Australia a compulsory examination as to quality of export butter has been introduced. According to the result of the examination, the butter is marked for the

first quality with the words: "Commonwealth of Australia, approved for export" (Fig. 8, *a*); for the second quality with the words: "Commonwealth of Australia, passed for export." (Fig. 8, *b*.) In accordance with the official standards (Statutory Rules, 1913, No. 317), no fat may be found in the butter except butterfat; the water percentage may not exceed 16 per cent, and the butterfat percentage must amount to at least 82 per cent.

From the preceding synopsis, it appears sufficiently that by means of the control already existing in several countries for the export of

Australian Government butter brands.



a.



b.

FIG. 8.—Australian Government butter brands. (*a*) For first quality. (*b*) For second quality.

butter, foreign purchasers are offered guaranties as to the purity and genuineness of the butter, and in some countries security is given as to its good quality.

These guaranties will be of greater importance when the exporting country allows no butter to be exported save what is controlled in this way, as is the case at this moment in Denmark, the Netherlands, Australia, New Zealand, Livonia, Esthonia, and Finland.

The honest butter trade is benefited to the utmost degree by this system of control, which is an advantage to the consumer. Direct cooperation (uniformity in the methods of examination, etc.,) of the several offices which supervise, in the respective countries, the ob-

servance of the regulations concerning the requirements of pure butter will preclude erroneous judgment of the commodity and check and detect infringements.

At the Third Dairy Congress, Scheveningen [The Hague] in 1907, a wish was expressed "that the import of unmarked butter, coming from countries where an effectual system of control of the purity of butter is established, should be refused." To which was added, "that no security exists against the import of adulterated butter, unless the import be refused of all butter that in the country of origin is not under Government supervision, and if it does not bear a mark from which it appears that it has been submitted to the above-mentioned supervision."

In order to show the useful work of the butter control to better advantage, it is proposed that countries of import acknowledge the guaranties given by the control, and consequently also the Government marks, with a proviso that examination will take place in cases where special reasons give occasion for it.

To further the efficacy of the control, I recommend the desirability of direct consultation between the officials of the different countries in order to mutually enlighten and assist each other in combating fraud. It is proposed:

1. That for the purpose of facilitating importation, the advantage of guaranties given by a Government butter control or by a private butter control under Government supervision be recognized by the country of import.

2. That direct contact be furthered between the several officers charged with supervision of the observance of control regulations concerning the import and export of butter, thereby furthering the provisions of proposal 1 or its equivalent in facilitating importation.

Chairman FLANDERS. Ladies and gentlemen, you have heard Doctor Swaving's paper. Are there any who desire to ask questions?

Dr. H. W. REDFIELD (Bureau of Chemistry, United States Department of Agriculture). I am very much interested in the butter which is exported from foreign countries to this country, for the reason that I have charge of the New York laboratory of the Bureau of Chemistry, and we pass upon practically all the butter which comes from foreign countries to New York. In that connection, we are interested in knowing exactly what all of the marks mean in relation to the different brands.

In the lantern slides which were shown this morning, I notice that there were two numbers, 3419 and 1220. I would like to be informed as to the difference in these numbers.

In connection with the Australian butter, I notice one is marked "Passed for export," and the other, "Approved for export." I am wondering whether those are different agencies, or whether they mean the same thing.

Doctor SWAVING. That first question you put to me is in connection with what country?

Doctor REDFIELD. The Finnish butter.

Doctor SWAVING. The difference in numbers indicates the dairies. The labels you saw were from different dairies.

In answer to your second question, as I told you, the butter exported from Australia must be examined. That which bears the mark, "Approved for export" is first quality. The other is of lesser grade and must be marked "Passed for export." There is a difference in quality.

Chairman FLANDERS. The chair understands Doctor Swaving to say that the second grade mentioned was not first quality, but could be passed for export.

If there are no other questions, we will pass on the next paper.

Mr. H. P. CASSOU (Paris, France). I would like to ask Doctor Swaving how we could have an international butter grading fixed here, as the congress is not supposed to pass any resolutions. Besides, Doctor Swaving in his paper proposes some general regulations as to international standards, and I find that the standards in every country are somewhat different. If we come to international control, as Professor Swaving proposes, how does he think this international grading of butter could be arranged? By means of what organization, a commission, another dairy congress, or what?

Chairman FLANDERS. The chair understood Doctor Swaving to say the standard for water was not to exceed 16 per cent; the standard for fat was not to exceed 80 except one, and that was 82. The question you ask is, if it is proposed that there shall be an international standard fixing body, what, if any, suggestions has Doctor Swaving to make?

Mr. CASSOU. The congress is not supposed to pass a resolution that could guarantee by government control or government supervision the control of the standards of butter.

Doctor SWAVING. I should like to say that my final proposals are not the same as I have given them here, as I have changed them.

Mr. CASSOU. There are countries which have no butter control. France is not a country which has official butter control, and it is on the whole a butter-importing country, although in some parts of France they do export butter, namely, to England. We have no butter control, but we have very strict regulations which control the quality of our butter properly, although not officially, and it amounts to much the same because the Government officials are always allowed to go and examine the quality of the butter. In fact, according to these regulations the French butter sells at as high a price on the London market as any other imported butter. If we come to international control, so that standards must be fixed, what is the way you propose to do it? Do you mean to have a meeting of the different associations interested in the different countries?

Doctor SWAVING. The conclusion has been changed somewhat.

Mr. CASSOU. Your conclusion is that the official control of the country is not quite enough, but that international regulations should be taken into consideration as well and that an international control should be established for those countries which are mainly exporters. Is that your idea in your conclusion? You said you changed the conclusion.

Doctor SWAVING. I said that if an international standard for butter was to be established for the guaranty of importing countries, there would have to be taken into consideration not only the Government control already existing but also the regulations in other

countries, and that we should adopt a system of regulations guaranteeing the quality and purity of the production.

Mr. CASSOU. Yes; but how do you propose that this be done?

Chairman FLANDERS. I think we shall have to defer further discussion on this paper until we have completed the discussion on the other papers.

We will now take up the paper, "Cheese control," which will also be presented by Doctor Swaving.

CHEESE CONTROL.

A. J. SWAVING, Ph. D., inspector of dairying, chief of dairy division of the general direction of agriculture, Ministry of Home Affairs and of Agriculture, The Hague.

The circumstance that, in consequence of taking off fat from cheese milk, cheese was made in the same shape but very different in fat percentage, so that skimmed-milk cheese could be sold as fat cheese, led the cheese makers, who were beginning to see the danger of the situation, to devise measures by which the value of their products might be guaranteed, and thus protect the fat cheese against dishonest competition of the skimmed-milk product.

In the Netherlands the cheese control was first brought about in consequence of the increased skimming of the cheese milk through factory butter making in some parts of the country, threatening the existence of whole-milk Gouda cheese and the real Edam cheese (day cheese) as a result of the making of skimmed-milk cheese in Gouda and Edam shape.

Cheese-control stations were established, the members of which submitted, of their own free will, to a severe control system, and guaranteed a fixed fat percentage in the cheese, and at the same time guaranteed that the cheese was made exclusively from milk without the addition of other fats.

The Dutch Government lent assistance by the disposal of Government marks to those stations, in behalf of their members, and, besides, by superintending the observance of the conditions and designations under which the marks in question were distributed.

The cheese marks, made of casein, are perforated and printed in mirror writing with superscriptions indicating the origin of the cheese (name of the control station, name of the maker, etc.). They are placed with the printed side on the curd; then by pressing and by competent manipulation of the cheese, as well as of the mark, the mark is attached to the cheese rind. The characters and letters placed on the mark, if necessary after cleaning the rind, will always remain distinctly visible.

As in the Netherlands, a few other countries, such as Denmark (1921) and Norway (1922), have instituted an official cheese control.

I may be allowed to refer to my "Collection of legislative measures concerning cheese," in which the legislation about cheese, or the regulations concerning cheese which are in force in a great number of countries (about 35), are recorded.

It will be seen from the collection that the indispensable uniformity for the world's commerce as to the requirements for cheese is wanting,

that a great deal of uncertainty prevails, and that in some countries little or nothing is done in this respect.

In my report about cheese control, a few things are mentioned of what is done in some countries. The principle of this control is based on a supervision of the cheese factories by taking samples of the milk and of the products at irregular times, while the cheese makers themselves are bound to observe particular conditions. It is endeavored to give, in this way, sufficient guaranties concerning the genuineness and the purity of the product.

In order to advance this movement in favor of combating fraud in the cheese trade and to further the useful operation of the cheese control, it is proposed that the countries of import shall acknowledge the guaranties given by the control, with a proviso that examination will take place in case the authorities concerned should give special use for it. To further the efficacy of this control, I recommend a direct consultation between the officials of the different governments in order to mutually enlighten and assist each other in combating fraud. It is proposed:

1. That for the purpose of facilitating importation, there be recognized by the country of import the advantage of guaranty given by a government cheese control or by a private cheese control under government supervision.

2. That a direct contact be furthered between the several officials charged with the supervision of the observance of the control, regulations, and so on, concerning the import and export of cheese, thereby furthering the provisions of proposal 1, or its equivalent, in facilitating importation.

The intention of these proposals is to further the interest of the honest cheese trade and to prevent mistakes or injustice when cheese is examined. This matter implies, among others, questions about sampling and chemical examination. Therefore it will be necessary that the official experts of the importing and exporting countries agree as to the preceding subjects.

Whereas in this meeting concerning the different proposals as to cheese, discussions will in the main be held only about questions of principles, it is my opinion that it will be advisable to submit the elaboration of the questions discussed here to a special committee.

Chairman FLANDERS. Ladies and gentlemen, you have heard the paper just read by Doctor Swaving. Are there any questions you desire to ask?

Mr. CASSOU. I have a point to raise which is practically the same as that raised in connection with butter. The difference is that cheese is of a much more complex nature. There are grades of butter, but there are lots of kinds of cheese. There, again, you must take into consideration the regulations in the countries where the cheese has originally been produced. You mentioned government control for cheese. That applies practically only to Denmark.

Dr. SWAVING. We have our cheese control under government supervision. That is practically the same.

Chairman FLANDERS. Is any one present to read Professor Huyge's paper? If not, we will proceed to "International nomenclature

for cheese brands; more uniform standards for fat control in different varieties of cheese; uniform methods of examination of cheese," which will be presented by Doctor Swaving.

INTERNATIONAL NOMENCLATURE FOR CHEESE BRANDS; MORE UNIFORM STANDARDS FOR FAT CONTROL IN DIFFERENT VARIETIES OF CHEESE; UNIFORM METHODS OF EXAMINATION OF CHEESE.

A. J. SWAVING, Ph. D., inspector of dairying, chief of dairy division of the general direction of agriculture, Ministry of Home Affairs and of Agriculture, The Hague.

I beg leave to observe that these questions from a commercial point of view are of great international interest.

I may refer to my "Collection of international measures concerning cheese," which proves how little accordance exists between the present measures in this matter in the different countries in the world, some of them having even settled nothing therewith.

A paper has been presented by me in the name of the national committees of five countries, namely, of Denmark, Holland, Norway, Sweden, and Switzerland, containing the following proposals:

1. The designations Emmenthaler, Gouda, Edam, Roquefort, Gorgonzola, etc., are regarded as names of kinds of cheese.

Imitations for home consumption, as well as for export, should be stamped distinctly with the names of the foreign countries concerned; for example, Danish Roquefort, Dutch Cheddar, Norwegian Edam cheese, Swedish Gouda cheese, etc.

2. All cheese which is expressly designated as "whole milk" cheese or "full cream" cheese or by similar name, must contain at least 45 per cent of fat in the dry substance.

If cheese is sold without special mention as to fat content it is understood to contain at least 45 per cent of fat in the dry substance. In this regard exception is made of Cheddar cheese and Roquefort cheese, which must contain at least 50 per cent fat in the dry substance.

Proposals are to be made by the international cheese committee concerning definitions of whole-milk cheese, full-cream cheese, or any cheese with a similar name.

Kinds of cheese made from more or less skimmed milk should contain at least 10, 20, or 30 per cent fat in the dry substance. For special kinds of cheese, special minimum fat standards are allowed, for example: For Gouda cheese, 30 and 20 per cent; and for Edam cheese, 40, 30, and 20 per cent of fat in the dry substance.

3. Uniformity of the prescriptions for the taking of samples and for the chemical examination of cheese (moisture and fat) in case of objection when exported.

a. Sampling.—This should, of course, be done judiciously in accordance with the kind of cheese and its size. For certain groups of kinds of cheese, special prescriptions shall be given.

b. Chemical examination.—As a uniform method it is proposed to have:

1. A simple prescription as to the determination of moisture.

2. The Schmid-Bondzynski-Ratzlaff method for the determination of butterfat.

The directions for the application of the proposed determination of moisture in cheese point out the principles only and give room to the chemist to act for himself to some extent.

As to the determination of fat, the method Schmid-Bondzynski-Ratzlaff, which is giving good results and takes not so much time, is recommended.

Chairman FLANDERS. The speaker suggests that there may be some points raised; for instance, if Roquefort is made in a certain country, whether the name of the country should be added as the prefix of the name of the cheese. It is a well-known fact that we run across a cheese occasionally in this country that is marked Danish style.

Mr. CASSOU. I am connected with the Gervais manufacturers, and I mention that cheese because this name is in Doctor Swaving's nomenclature. Gervais makes several kinds of cheese. There is a Gervais cheese, which is cream cheese; there is Gervais Camembert cheese, etc. They are manufacturers, and that is not a name for a certain kind of cheese. How would you describe cheese you call Gervais?

Chairman FLANDERS. The chair understands that the question is whether the name used is the name of a well-recognized make of cheese, not the maker.

Mr. CASSOU. There is also Roquefort cheese, for instance. It is not the name of a manufacturer, but any kind of blue cheese can not be sold as Roquefort. Therefore, before going any further into such a proposal, it should be necessary to get the dairy associations of the countries of origin of the cheese to express their views on such regulations. As I happen to be interested personally in the Gervais, I will take that as an example. Professor Swaving could not give a definition of Gervais. They manufacture several grades of cheese. You mention the names of some foreign countries which are back of this proposal. I think you should get a few of the dairy associations of the countries of origin of this cheese; for instance, Gorgonzola is an Italian cheese and Roquefort is a French cheese.

Chairman FLANDERS. The chair would suggest, as the time is going rapidly, that we defer this discussion until the close of the papers and take it up then if we have time.

Prof. S. ORLA-JENSEN (Royal Technical Agricultural College, Copenhagen). I should like to emphasize that all the old cheese names originally were used to describe the types made in a special country or in a special town in that country. Gouda, for instance, was made in the little town of Gouda. Emmental was made in the valley of the Emm, Switzerland. So the name was originally applied to all kinds of cheese.

Now we are making this cheese in different countries. Emmental is no longer just made in the valley of the Emm, but they are making it in the whole of Switzerland. No country can demand the keeping of this old name for its own country; but if the cheese is made in any country other than originally, we demand that the name of the country shall be on it. If you in France make a French cheese, it is not necessary to put the name of your country on it because it is a French cheese, but if we in Denmark make Roquefort cheese we must stamp it as Danish Roquefort cheese.

Mr. CASSOU. There are other manufacturers of fresh-cream cheese in France, and they must sell it under their own name. Gervais is the name of the manufacturer. It is not a generic name.

Dr. SWAVING. If there is no objection, I want to ask the chair if I may call upon the Swiss delegate whether he agrees to the name Gervais.

Prof. A. PETER (director, Dairy School, Rütli-Zollikofen). I have to deal with this in my position as director of the Zollikofen Dairy School. I am the president of the Swiss Milk Committee. I agree with the views of Doctor Swaving and also with the statements by Professor Orla-Jensen. We must make a difference between the name of cheese which indicates only the origin of the cheese. That is to say, Emmental cheese, Gouda cheese, all these are made all over the world. Concerning Gervais cheese, we first made a certain cheese. Mr. Gervais, from Paris, made this cheese under a special process and had success. He called it Gervais cheese, after his own name.

Just before the war there arose a question as to whether Gervais was the name of a particular kind of cheese, or whether it was a trade-mark. It was decided it was a trade-mark cheese, and nobody could deal with this cheese under the name Gervais. I believe Gervais is the name of a trade-mark cheese and that it should be withdrawn from the list.

Mr. FREDERIK A. BENZINGER (Stockholm, Sweden). If Gervais claims that is a trade-mark name, we, of course, have no right to designate it otherwise.

Chairman FLANDERS. It is necessary that we defer this discussion until the end of the program. The next paper is entitled "In behalf of an international control for cheese trade," by G. Fascetti, director of the cheese experiment station, Lodi, Italy.

It appears that Mr. Fascetti is not present, so we will proceed to the paper, "Cheese nomenclature," by Doctor Porcher of Lyons, France.

Mr. CASSOU. As it was necessary for Doctor Porcher to leave for New York, he is unable to attend the session. He has asked me to give a summary of his paper in English.

Chairman FLANDERS. We will now hear Mr. Cassou present Doctor Porcher's paper. [Applause.]

CHEESE NOMENCLATURE.

CHARLES PORCHER, D. Sc., chief, department of physics, chemistry, pharmacology, and toxicology of the National Veterinary School, Lyons, France.

Among the numerous questions of scientific and economic importance being discussed at this congress, that of the origin of names in the cheese industry and cheese nomenclature is well worth considering and has attracted the attention of several delegates from various countries.

In France, where a great variety of the most appreciated cheeses are produced, that question of the names of origin has long since been given careful attention, and the difficult problems it raises have been amply studied and practically solved. For these reasons I think that the indication of the regulations in France will be of in-

terest to our congress when examining the question from an international point of view.

A law passed by the French Parliament a few years ago exclusively deals with names of origin, and when being discussed it was described as "a law to take place among those which, in an economical state of free competition, safeguard the loyalty of the transactions." It is a law that fills the gap that existed between those regulating trademarks and those for the repression of frauds and adulterations. It is a law which is meant to guarantee the honesty and loyalty of commercial transactions and is based exclusively on common sense, reciprocal confidence, and justice.

Studying the question from our international point of view, we must not try to go fully into every special case, but we must try to determine general rules which can be applied to the various products.

All those who have studied this question have come to very nearly the same conclusions which they have expressed in more or less precise terms, i. e., that the origin of the product should be so clearly indicated to the consumer that, in case it is possible to make imitations of a cheese in a country other than the country where it has originally been produced, the consumer can always distinguish these imitations from the genuine original cheese.

Some have gone as far as to ask that the guaranty resulting from government regulations in the country where the cheese has been originally produced should be sanctioned by the import countries and that the respective marks and exclusive names be acknowledged by them, a direct contact being established so as to enforce the observance of these regulations.

This seems quite just and in conformity with that maxim which is universal in the United States, namely, the ignorant are to be protected.

It is because of this rule that the United States food and drugs act prohibits the import of whatever product which is not in conformity with the legal requirements of the country of its origin. For instance, any French cheese that would not be entitled to any special name by the French regulations could not be imported into the United States under that name.

The reason for this is that if the ignorant consumer is to be protected, no doubt must be created in his mind.

In a few words, this means that the quality of any product and, namely, that of any cheese, should be everywhere identical and that the legal requirements of the country where it was originally produced should prevail in all the other countries.

As these legal requirements may vary according to the products, the rules to be established should be general enough to apply to the numerous and complex cases that exist. A first rule could deal with a very few clear cases and another with the other ones.

That first rule could be as follows:

The cheeses essentially determined by their composition, their process of making, their place of origin, and eventually the name of the manufacturer, should be protected against all imitations, native or imported, even when this imitation would only consist in the use of the name of the original product or of the original place of pro-

duction, with or without another name of country, with or without a qualification, a corrective or any other word.

This first rule, for instance, could apply to such cases as the French Gervais cheese, or to Swiss Emmental when sold under the sole name of Swiss cheese. It could also eventually apply to special domestic cases such as that of Sharples Anchor cheese, as has been proven by a recent trial case before the United States courts.

A second rule could apply to less clear cases; i. e., to practically all the cheeses produced in the various countries. It could read as follows:

If the consideration to be given to already existing situations does not allow in certain cases the logical application of the principles of justice expressed in the previous rule, the qualification "genuine" should be exclusively reserved for the product of real origin, and the imitations should be so named and presented to the public that no confusion between them and the original product could be possible.

This second rule would apply to such cheeses as Cheddar, Emmental, Camembert, Gorgonzola, etc.

Chairman FLANDERS. We will now hear a paper on "The coordination of Federal, State, and municipal control," by Mr. W. S. Frisbie, of the Bureau of Chemistry, United States Department of Agriculture. [Applause.]

THE COORDINATION OF FEDERAL, STATE, AND MUNICIPAL CONTROL.

WALTER S. FRISBIE, chemist in charge, Office of Cooperation, Bureau of Chemistry, United States Department of Agriculture.

The question of coordinating laws is by no means a new one. Ample illustration has been given in the past of the extent to which the existing laws, ordinances, and regulations vary, and to mention only two of these, one may cite the report of a committee on statistics on milk and cream regulations from the Dairy Inspectors' Association, which reported in Springfield, Mass., in October, 1916. A later survey reported by Professor Hiscock, of the committee on municipal health department practice, appeared in the July, 1922, number of the American Journal of Public Health. From the data published in these reports as well as from those secured from the laws and ordinances presumed to be in force at the present time, the observations here recorded were obtained.

It should be stated at the outset that so far as Federal laws are concerned, the regulations are practically nil. The only Federal regulatory law is the food and drugs act of June 30, 1906, commonly known as the pure food law. This includes the supervision of milk products in common with other foods, but makes no specific reference to milk or any of its products. It is true that certain administrative standards have been published, chemical standards, however, and not bacteriological, but these relate entirely to the freedom from common adulterants, such as preservatives and water, and to the assurance that the product shall not be filthy, decomposed, or putrid

within the meaning of the act. No regulation has been announced so far as bacterial contamination or conditions surrounding source of production are concerned. This leads us, then, to a consideration of the State and municipal laws and regulations. Of these the municipal regulations are perhaps of most importance, since the large cities have found it necessary, in order to properly safeguard the health of their inhabitants, to promulgate the most complete and stringent ordinances regulating the production, distribution, and sale of milk and its products.

A study of the two reports mentioned, as well as of the existing requirements in the larger cities of the United States, indicates at least two outstanding points on which there is a regrettable lack of coordination. One of these is the number of grades of milk in those cities wherein grading of milk is provided for, and the variations in requirements for milk of the same designated grade in different cities. The second point, more or less dependent on the first, is the variation in requirements for sanitary conditions of farm dairies supplying the various grades. According to the report of the committee on municipal health department practice, grading is practiced in 31 out of 83 cities studied. These 83 include all of the cities of 100,000 people and over and a few under that figure. The following grades of milk will be found defined in the ordinances of the several cities studied: "Certified"; "Inspected"; "Guaranteed"; "Select raw"; "Select Pasteurized"; "Inspected raw"; "Registered"; "Grade A raw"; "Grade A Pasteurized"; "Grade B raw"; "Grade B Pasteurized"; "Grade C Pasteurized." One city, in addition to the "Certified," lists grades "A," "B," "C," "D," and "E."

The lack of uniformity is apparent when we consider the following definitions: "Certified," in general, is defined as raw milk having less than 10,000 bacteria per cubic centimeter when delivered to the consumer, and in all instances required to be produced from tuberculin-tested and tuberculosis-free herds. There is a variation, however, in some of the requirements so far as the dairy sanitary score is concerned. In several of the ordinances, certification is left entirely to the rules and regulations of a local city or county medical commission, which, without any question as to its efficiency, is not directed by the ordinance to demand uniform requirements or standards for certified milk.

The terms "select," "inspected," "registered," etc., generally designate milk of a high grade generally comparable to the "grade A raw" milk. This grade, however, varies in the various cities; one with a requirement of not over 30,000 bacteria, to another permitting up to 100,000 bacteria. Sanitary scores will be found to vary from 65 to 95. Similar variations can be shown for "grade B Pasteurized." "Grade B raw" is provided for in only a few instances. The same is true of "grade C," "Grade D" and "grade E" are defined in only one city studied.

There is an extreme variation in the requirements for the sanitary score of the dairies, not only with respect to the sanitary conditions required for a certain grade of milk, but for the minimum requirements for the milk supply in those cities where a grading system has not been installed. The report of the committee on statistics on milk and cream regulations found a variation in minimum dairy farm

score requirements in cities of 100,000 and over of from 46 to 80 per cent. Similar variations, although not perhaps so extreme, are observed in the definitions of similarly designated grades in the different cities.

The point may be raised that it is not exactly fair to cite variations in sanitary requirements when it is known that the score card is not in all cases identical. Most of the requirements indicate the use of the score card suggested by the Dairy Division of the United States Department of Agriculture, and I believe that where no direct injunction is expressed it is generally the practice of the dairy officials to make use of this scoring system. There are other score cards, however, the use of which is required in certain ordinances, and while a comparison, therefore, of the different gradings required is not exactly on an equitable basis, it is believed that fundamental requirements are practically the same in any recognized official scoring system.

In addition to the above points, there may be mentioned another instance of lack of coordination, and that is with respect to the inconsistencies which occur in the State laws and those laws or ordinances passed by the several municipalities within that State. As a rule, the State statutes are more general in their provisions, and, except for the usual physical and chemical standards, fundamental requirements for the health of herds, sanitation of the dairy premises, and cleanliness of utensils, lack the specificity which is characteristic of the city ordinances. This lack of coordination does not interpose any legal barriers either in State or municipal proceedings, but does furnish a very practical illustration of an unfortunate situation when it comes to actual inspection. The dairy inspectors for the State, in their rounds, will naturally enforce the law and the regulations only so far as they are legally empowered to do so. It is conceivable, then, that a State inspector may approve a dairy as being within the requirements of the law and that he may be followed by a municipal inspector who apparently reverses his decision and requires further changes in the establishment before such milk can be sold in the municipality which he represents. When these incidents are repeated, one sees a very urgent reason for desiring greater uniformity and coordination, and this without indicting either the State or the municipal laws, either on the ground of undue laxity or overexacting requirements.

We may ask what are the results of such lack of coordination. One result, it would seem, would be a corresponding lack of efficiency or supervision on the part of regulatory officials, and consequently by so much a failure to properly protect the consuming public in its use of a most important not to say vital essential of the diet. There should be cooperation among all those who are authorized to enforce the laws regulating the food supply of the Nation, and particularly when that product is milk and so closely allied with the question of public health. We can cooperate, it is true, without closely coordinated laws, but not so well, and it would therefore seem that if the official is to function as he should there should be well-defined efforts, at least on his part, to secure greater coordination. Another result of the lack of coordination is the effect on the dairy industry itself.

The milk supply of this country is dependent largely on the small or average herd. Statistics show that practically 50,000 herds or producing farms are required to supply New York City with its 4,000,000 pints daily consumption of milk, or an average of 20 gallons to the individual farm. Conflicting regulations and varying standards are many times irritating to the dairy farmer, and certainly do not tend to encourage the growth of the dairy business. This point is more particularly emphasized by those farms located near to or supplying congested centers of population. The producer is subjected to the State regulations of the State in which his farm is located; and if he ships to an adjoining State, he is also subject to inspection by that State and also the municipality within it which consumes his milk. That this is not entirely an academic question can be attested by those in administrative positions who have based their plea for better coordination on the basis of such existing conditions.

Admitting, then, the desirability of better coordination, how shall we proceed to secure this uniformity? Legislation may be suggested which is so often considered the panacea for all of our civic ills, but the question may be quite appropriately asked if we are not already attempting to counteract in a measure errors of omission or commission, so far as legislation itself is concerned. We might conceive of an act of Congress which would provide uniform standards of production, transportation, and delivery, including the manufacture of milk products throughout the United States. The constitutional lawyers might advise us, however, that this would be impossible without a constitutional amendment, and that under the present conditions Congress would be limited to the control of those products which are shipped in interstate commerce or sold in the Territories or insular possessions. As a Nation, however, we are inclined to be individualistic and to maintain the integrity of our political subdivisions, so that the possibility of any such national laws is at the present time somewhat remote. Legislation in the several States, however, can be effectively directed toward the coordination of our dairy laws by incorporating therein certain provisions as to the limitations of the municipalities to diverge from the statute of the State except as directed and provided in the State law. This would assume a complete and inclusive dairy law for the various States; but with the wealth of information at our command, it would be no difficult task, it would seem, for those specialists in this subject to properly advise legislatures, should a demand be expressed for such a type of legislation.

In the absence of any legislative enactment whatsoever, it seems there can still be a vast amount of progress made by the concerted effort of regulatory officials, both State and municipal, to promulgate uniform rules and regulations. This will make for coordination in administrative procedure, since concerted action has already been accomplished on the part of officials so far as food and drug products in general are concerned, and of which I have been pleased to make mention on previous occasions. This suggestion is not a new one, nor do I claim for it any originality whatsoever. Similar action has been suggested in the past, and in 1916 a resolution was

adopted by the International Association of Dairy and Milk Inspectors, at their Springfield, Mass., meeting, to the effect that since such wide variations had been shown in the existing laws, ordinances, and regulations governing the production, distribution, and sale of milk, it was desirable for the development of this industry to secure a greater degree of uniformity, as a result of which a committee was appointed to make a study and recommendation. This resolution was also presented to four other associations, with the suggestion that similar committees be appointed. I am not in a position to say just what have been the actual results of the appointment of these committees, nor is it easily possible to measure with any means at our command the progress which has been made since that date toward uniformity of inspection methods. A brief comparison of the figures in the 1916 report with those recently collected, indicates that there has been material progress, but I believe you will agree with me that there is still room for our united efforts toward a more complete coordination, not alone for the benefits which may accrue to the dairy industry itself, but especially that we may more effectively safeguard the health of the people, particularly infants and children, in whose lives milk is the most important element of food we know.

These observations relate entirely to conditions in this country. Since this is an international congress, however, it might not be out of place to mention that if coordination is desirable in this country it is probably desirable with other countries as well, particularly in regard to the manufacture of dairy products.

You will remember at the Washington session, those of you who were there, that the Secretary of State spoke on international cooperation, particularly in view of the importance of this industry to all people of the world.

It is my understanding that this Dairy Congress can not appropriately pass a resolution. If it is desired, as I learn it has been expressed in other ways, to effect a coordination or standardization of manufactured dairy products, I am safe in saying that the Bureau of Chemistry, which I represent, would be only too glad to do all in its power to assist such a committee or body as may be formed at this congress or at a future time.

Chairman FLANDERS. The time is yours, gentlemen, for a few moments if you wish to ask a question. If you do, make it brief and to the point. If not, the next paper is "Creamery and testers' license laws" and will be presented by Mr. H. W. Gregory, chief of the department of dairy husbandry, Purdue University. [Applause.]

'CREAMERY AND TESTERS' LICENSE LAWS.

HOWARD WILBUR GREGORY, chief, department of dairy husbandry, Purdue University, Lafayette, Ind.

In preparing this paper for the World's Dairy Congress, I have considered the different dairy laws in the different States affecting the licensing of creameries and testers, and I speak of them in this paper as creamery and testers' license laws even if they are not

spoken of as such in the different States. You realize that each State has its own laws affecting such licenses.

In going over the different laws I could not help but be surprised at the lack of uniformity. A greater uniformity would be of much assistance to the glass manufacturers and would also establish more confidence among producers.

There is probably no State in the Union which has not experienced, at one time or another, the need of a law which would, to a certain extent, assure the farmers and dairymen who sell milk and cream on the butterfat basis that the test on which they market their milk and cream is being made according to recognized, official, and accurate methods of testing. By eliminating careless or inaccurate methods of testing, weighing, and sampling on the part of the agent or tester, such a law, if properly enforced, would also be of great assistance to operators of dairy plants which purchase milk and cream on a butterfat basis.

The demand for such a law as the creamery and testers' license law has originated in the past, as a general thing, with dairy farmers. After such a law has once been established, provided it has been wisely drafted and administered, the men engaged in the operation of dairy plants have been enthusiastic over the results accomplished and have given the State authorities responsible for its administration all the support possible in making it effective.

The creamery and testers' license laws have come about largely as a result of the variations in the milk and cream tests and the average tester's inability to explain to the farmers why these variations occur. Where there are no State laws requiring standard methods of testing, this condition has resulted in suspicion and dissatisfaction on the part of the milk and cream producers.

In States where investigations were conducted to determine if there was really a need for a creamery and testers' license law before such a law was in effect, it was shown that the farmers were justified in their request for standardized tests. This was due not so much to dishonesty in conducting the Babcock tests as to carelessness, ignorance, and unreliable methods of testing found in determinations of the amount of fat in the milk and cream, as well as to carelessness on the part of some of the glassware manufacturers in the graduation of the glassware used in connection with the Babcock tests.

Before such a law went into effect in Indiana, we found 23.1 per cent of the milk and cream test bottles which were tested for accuracy inaccurate, while now, after the law has been in effect for 10 years and every piece of glassware used in connection with the Babcock test is retested for accuracy, we find only 0.07 per cent of inaccurate glassware.

In going over a number of the creamery and testers' license laws in different States, I find many States have either just recently adopted such laws, or have revised their old law. It is very noticeable that the more recent legislation, as a general thing, has eliminated rules and regulations which have been vague in meaning or which in practice seem unsuitable for effective application. A law, to have the respect and confidence of the men engaged in the industry, must be generally well understood, and must not be handicapped with rules impractical of application. It would seem that a

creamery and testers' license law, to be most effective, needs a great amount of educational work in connection with its enforcement. From the experience which we have had in enforcing this law in Indiana, we believe that the more generally the law is understood by the men engaged in the dairy industry, the more support we have in its enforcement.

For this reason, each year in January or February we offer at the university a one-week short course for creamery field superintendents. We usually have from 25 to 40 men for this course. These field superintendents are employed by milk and cream companies for the purpose of establishing buying stations, teaching new operators how to test milk and cream, and for general supervision of the milk or cream buying stations belonging to such companies. The instructional work in this short course consists in familiarizing the men with the creamery and testers' license law. Discussions are taken up on the finer points of the Babcock test, factors causing variations of tests, farm separators, dairy-farm problems, and many other subjects which would be of use to the field men in their work. The creamery inspectors assist our regular instructors of the dairy department in giving this work. We have found that this short course has aided us very materially in our work in enforcing the creamery and testers' license law in Indiana.

In preparing this paper I wrote to each of the 48 States and requested a copy of the State law affecting the licensing of creameries and milk and cream testers. I received replies from 41 States. Thirty of the States replying have what may be called a creamery and testers' license law. Eleven of the 41 States do not have any law of this kind. Three States which have a law were unable to send copies in time to include them in this paper.

In going over the laws, I find there is very little uniformity in the administration or the requirements in the different States. Unfortunately, in some States the law has been placed on the books either without any financial provision for putting it into effect or with such a small amount of financial assistance that it is impossible to make the law effective. A few of the States have laws containing provisions which are undoubtedly impractical of enforcement.

ADMINISTRATION.

The responsibility for the administration of the creamery and testers' license laws in the 27 States which are considered in this report usually rests upon one of two State departments: Either the State department of agriculture or the agricultural experiment station, or, sometimes, the two departments acting jointly. In 21 of the States the law is administered through the State department of agriculture; in 4 States the law is administered by the agricultural experiment station, and in 2 States the law is administered jointly by the State department of agriculture and the agricultural experiment station.

CREAMERY LICENSES.

There is a great deal of variation among the different States in the requirements of plant or station licenses. There are only 4 States, out of the 27 studied, that require a plant license on the condition that the plant or station is buying on a butterfat basis. Ten

of the States require the licensing of plants or stations regardless of whether the milk or cream is bought on a butterfat basis or not. Thirteen States require no license whatever as far as the testing of milk and cream is concerned. The charge for the plant license in the different States studied varies from nothing to \$10. In three States the fee depends on the amount of products handled. Some of the States make a difference in the fee charged for a creamery license and a station license. Where such a difference exists the station license represents the smaller fee.

TESTERS' LICENSES.

In the 27 States reporting a creamery and testers' license law, all require the tester to hold a license before he can test. The charge for such a license varies from nothing in three States to \$5 in one State; the fees ordinarily cost \$1 or \$2. Many States charge different fees for a license, depending on whether it is a renewal of a previous license; renewal costs are usually lower than the original license charge. There is some variation in the length of time before the tester is required to renew his license. One State issues a license which is valid until revoked, but as a general thing most States issue a one-year license, which may be renewed upon payment of the license fee and without reexamination.

All States give some kind of an examination to applicants for testers' licenses. These examinations, however, vary considerably. In some States the examination consists of sending out questions to the applicant to be answered and returned. Other States require the applicants to meet at a designated place in the State and an examination, both written and oral, as well as laboratory exercises in connection with milk and cream tests, are given. Three States require permits for sampling and weighing cream. There is no charge for this permit in any case.

Eight of the 27 States specify that 8 per cent milk test bottles must be used. Four States specify that 10 per cent milk bottles must be used. Eight of the States permit the use of 9 and 18 gram cream test bottles, while five States only permit the use of 9-gram cream test bottles. In each case the 6 or 9 inch neck cream test bottle is permitted. Fifteen States retest all glassware used in the Babcock method of testing, and the charge for this service varies from nothing to 5 cents per piece; 3 cents is the most common charge.

Eighteen of the 27 States require that the cream and milk tests be read in water baths. The temperature required for reading the milk and cream tests varies in the different States from 120° to 150° F. Only 6 States specify the length of time to which the test must be subjected to this temperature before reading results.

Only 5 States of the 27 States having a creamery and testers' license law receive State appropriation for carrying on the work connected with the law. One State received \$10,000 the first year, and the other four States received annual appropriations varying from \$1,000 to \$3,000.

REVOKING LICENSES.

In most of the States the license required by the cream testers' license law may be revoked upon submitted evidence showing that

the creamery or the cream tester has violated any rule or regulation of the law. These licenses are usually revoked by the commissioner of agriculture, or the director of the agricultural experiment station, or a dairy commissioner, who usually comes under the commissioner of agriculture. Two States—Indiana and Kentucky—have what they call an examining board, before which all cases for revoking licenses are brought. These boards, in turn, recommend the revoking of the license to the director of the experiment station.

PENALTIES.

The maximum penalty for the violation of this law in the different States varies from \$500 to \$1,000, and from 30 days to 12 months imprisonment.

Since those of us who have been in close touch with the Indiana creamery and testers' license law believe that this law has been very successful in its operation, and since I am more familiar with this law than any other, I will give you a brief outline as to its requirements and how it is enforced.

The law in Indiana is administered by the State agricultural experiment station and a division of the dairy department, created to put this law into effect. One thousand dollars a year is received from State appropriation, in addition to the fees collected annually from creamery and testers' licenses. Each year we issue between 1,800 and 2,000 plant licenses and approximately 2,500 testers' licenses. For each plant or station license a charge of \$6 is made, and for each tester's license a charge of \$2 is made.

We give the applicant for a tester's license a very complete examination. The examination consists of a written examination and a laboratory exercise in the testing of milk and cream. These examinations are held at eight different points in the State, usually one month apart. Approximately 1, out of every 10 taking the examination, fails to pass.

When an applicant successfully passes the tester's examination he is issued a certificate, and upon receipt of this certificate he may receive his license at any time by paying his license charge of \$2.

From three to four men are employed in the creamery license division of the dairy department to carry out this law. The revoking of a creamery or tester's license is made by the agricultural experiment station only upon recommendation of the examining board. The examining board is composed of seven members; three appointed from the State dairy association and three from the dairy manufacturers' association. The seventh member, who is the chairman, is the chief of the dairy department of Purdue University.

Cases which need attention are brought before the board, with the evidence that has been collected by the inspectors. The operator whose license is to be considered for revocation is notified when his license is to be considered (the company for whom he is working is also notified) and he is requested to appear before the examining board to show why his license should not be revoked. We have been very careful in securing evidence for the revoking of a license. The evidence which is submitted to the examining board for its consideration would be considered by the average person, I believe, very complete, and is a result of several inspections. We seldom submit

TABLE I.¹—Data taken from 27 States having a law that may be termed a creamery and testers' license law.

State.	When enacted or amended.	Administered by.	Creamery license required.	Testers' license required.	Examination given.	Kind of glassware allowed.	Glassware retested for accuracy.	Temperature required for water bath.	Penalties.	State appropriation for.	Remarks.
Arizona.....	Enacted 1918; amended 1919.	State department of agriculture.	Yes; all plants if buying on butterfat basis or not.	Yes; \$1.50 fee; good 1 year; tester must give \$1,000 bond.	Yes; certificate issued at university.	8 per cent milk; 50 per cent, 6-inch, 9-gram; 50 per cent, 9-inch, 9-gram; 50 per cent, 18-gram.	No.....	120° F. for 10 minutes.	Not to exceed \$200....	\$10,000 for first year...	Tester's license revoked by commissioner.
Colorado.....	Enacted 1921; amended 1923.	State dairy commission.	Yes; station, \$2; all other, \$10, if buying on butterfat basis or not.	Yes; fee, \$1.50; good 1 year.	Yes; unless have had course at dairy school.	10 per cent milk; 50 per cent, 6-inch, 9-gram; 50 per cent, 9-inch, 9-gram; 50 per cent, 18-gram.	do.....	120° to 130° for 5 minutes; with glymol, 135° to 140° for 5 minutes.	\$10 to \$200 or 60 days..		Tester's license revoked by commissioner.
Connecticut.....	Amended 1923.....	State department of agriculture.		Yes; good 1 year.....	Yes; \$1 charged to take examination.				Not to exceed \$50 or 60 days.		Requires samples to be held 10 days; license to sample required.
Idaho.....		Department of public welfare.		Yes; fee, \$2.50; good 1 year.	Yes.....	50 per cent 6-inch, 9-gram; 50 per cent, 9-inch, 9-gram; 50 per cent, 18-gram.	No.....	120°.....	\$25 to \$200, 30 to 60 days.		License revoked by department of public welfare.
Illinois.....		State department of agriculture.		Yes; fee, \$1; good 2 years.	do.....	10 per cent milk; 50 per cent, 6-inch, 9-gram; 50 per cent, 9-inch, 9-gram; 50 per cent, 18-gram.	do.....				License revoked by commissioner.
Indiana.....	Enacted 1913.....	Agricultural experiment station.	Yes; when buying on butterfat basis, \$6.	Yes; fee, \$2; good 1 year.	do.....	8 per cent milk; 50 per cent, 6-inch, 9-gram; 50 per cent, 9-inch, 9-gram.	Yes; 3 cents per piece..	135° to 140° for 10 minutes, cream; milk, 5 minutes.	\$25 to \$1,000, 60 days to 12 months.		License revoked by examining board.
Kansas.....	Enacted 1915; amended 1922.	Dairy commission.....		Yes; no fee.....	do.....	Standard.....	Yes.....	130° for 5 minutes.....	\$25 to \$200.....		Require (1) permit to sample; (2) samples held 24 hours; (3) examination every 3 years.
Kentucky.....	Enacted 1918.....	Agricultural experiment station.	Yes; \$6 a year if buying on butterfat basis.	Yes; fee, \$2 per year.	do.....	8 per cent milk; 50 per cent, 6-inch, 9-gram; 50 per cent, 9-inch, 9-gram.	Yes; 3 cents per piece..	130° to 140°.....	\$25 to \$1,000, 60 days to 12 months.		License revoked by examining board.
Maine.....	Enacted 1919; amended 1922.	State department of agriculture.		Yes; fee, \$1.....	Given by State university.	Standard.....	By experiment station; no set charge.		\$10 to \$150, or 30 days.		
Maryland.....	Enacted 1920.....	State board of agriculture.		Yes; no fee.....	Yes.....		Yes.....				
Massachusetts.....	Enacted 1912.....	Agricultural experiment station.		Yes; \$2.....	do.....		Yes; 5 cents per piece..				License revoked by director; tester pays for examination at time.
Michigan.....	Enacted 1907; amended 1919.	State department of agriculture.	Yes.....	Yes; \$1; good 1 year.	do.....	8 per cent milk; 50 per cent, 6-inch, 9-gram; 50 per cent, 9-inch, 9-gram.	Yes; no charge.....	135° to 140°.....	Not to exceed \$100 or 3 months.		License revoked by commissioner of agriculture.
Minnesota.....	Enacted 1921.....	do.....		Yes; \$1; good 1 year.	do.....						
Mississippi.....	Enacted 1918; amended 1922.	do.....		Yes.....	do.....			125° to 140°.....			Require samples held 24 hours.
Missouri.....		State board of agriculture.	Yes; \$2.....	Yes; \$2.....	Yes (?).				\$25 to \$500; 30 days to 6 months.		License revoked by commission.
Montana.....	Enacted 1923.....	do.....	Yes; State, \$5; others depend on size.	do.....	Yes.....		Yes; done where used.	135° to 140° for 10 minutes.			18 grams cream required.
Nebraska.....	Enacted 1919.....	State department of agriculture.	Yes; depends on size; required when buying on butterfat basis or not.	do.....	do.....	10 per cent milk; 50 per cent, 6-inch, 9-gram; 50 per cent, 9-inch, 9-gram.	Yes; by experiment station; fee, 3 cents.	135° to 140°.....	\$10 to \$100, or 3 months.		License revoked by commission.
New Jersey.....	Enacted 1920.....	Agricultural experiment station.	Yes; no fee.....	Yes; \$3 first year; \$1 renewal.....	do.....	Standard.....	Yes.....	130° to 150°.....	\$24 to \$1,000; 60 days to 12 months.	\$3,000 per year.....	Director revokes license; sample must be tested in duplicate.
New York.....		State department of agriculture.		Yes; no fee; good 1 year.	do.....	do.....	Yes; by New York Experiment Station.	135° to 140°, 3 minutes.			Require cream sample held 24 hours; license revoked by commission.
North Dakota.....	Amended 1919.....	do.....	Yes; fee, \$10.....	Yes; fee, \$2.....	Yes; if course in testing has not been had.	do.....	No.....	120° to 150°.....		\$2,000 per year.....	18 grams cream required; sample held 24 hours; commission revokes license.
Oregon.....	Amended 1921.....	do.....	Yes; \$1 if buying on butterfat basis.	Yes; fee, \$5 per year.	Yes.....	8 per cent milk; 50 per cent, 6-inch, 9-gram; 50 per cent, 9-inch, 9-gram; 50 per cent, 18-gram.	Yes; experiment station; fee, 3 cents.	135° to 140°.....	Not to exceed \$250 or 12 months.		License revoked by commission.
Pennsylvania.....	Enacted 1919; amended 1920.	do.....	Yes; no fee.....	Yes; \$3 first year; \$2 renewal.	Yes; given at State college.	do.....	Yes.....		Not to exceed \$100 or 12 months.		License revoked by secretary of agriculture.
South Dakota.....	Enacted 1911; amended 1919.	do.....		Yes; fee, \$2 to \$3 for examination.	Yes.....	Standard.....	No.....	120° to 150°.....			Hold samples 24 hours; not to test after sundown.
Tennessee.....	Enacted 1918.....	do.....	Yes; \$6, if buying on butterfat basis.	Yes; fee, \$2 per year.	do.....	8 per cent milk; 50 per cent, 6-inch, 9-gram; 50 per cent, 9-inch, 9-gram.	Yes; fee, 3 cents.....	130° to 140°.....	\$10 to \$200; 60 days to 12 months.	\$3,000 per year.....	Commission revoked license.
Virginia.....	1916.....	do.....		Yes; fee, \$1.....	do.....	8 per cent milk; 50 per cent, 6-inch, 9-gram; 50 per cent, 9-inch, 9-gram; 50 per cent, 18-gram.	Yes; fee, 5 cents.....				License revoked by commission.
Washington.....	Enacted 1919; amended 1923.	do.....	Yes; \$10.....	Yes; fee \$2; good for life.	do.....	Standard.....	Yes.....	130° to 140°.....			License revoked by department.
Wyoming.....	Enacted 1921.....	do.....		Yes; \$2.....	do.....	10 per cent milk; 50 per cent, 9-gram; 50 per cent, 18 gram.		135° to 140°.....	\$10 to \$100 or 3 months.		License revoked by commission.

¹ This table prepared by R. L. Hammond, associate chief in creamery license division, dairy department, Purdue University.
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evidence for the consideration of the examining board until we have endeavored by educational means to correct the tester. Exceptions to this procedure would be where our evidence shows, without a doubt, that the tester is manipulating the cream or milk test intentionally. In cases that we have had which involve the plant manager and where we believe the revoking of his creamery license would probably not be justified, we have collected evidence and turned it over to the prosecuting attorney for prosecution. Dairy plants, stations, or testers who are found operating without a license are also prosecuted, after first being told the requirements of the law and after being given an opportunity to make application for a license. We usually have three or four prosecutions each year. Such cases, as a general thing, are not brought before the examining board for consideration. The number of testers' licenses revoked each year vary from 9 to 15. When a tester's license is revoked in the State, this action of the examining board is reported to every other tester in the State.

GLASSWARE.

The Indiana creamery and testers' license law specifies that cream-test bottles must be the 9-gram, either with the 6 or 9 inch neck, and graduated to 50 per cent. Milk-test bottles must be graduated to 8 per cent. Cream-test bottles must show no error of as much as one-half of 1 per cent at any point on the graduation. Milk-test bottles must show no error exceeding one-tenth of 1 per cent at any point on the graduation. The standard Babcock milk pipette must be used with a straight nozzle and a delivery tube which will enter the neck of the standard milk bottle.

WATER BATHS.

We also require that all cream and milk tests be read at a temperature of 135° or 140° F., and specify that these tests must be subject to these temperatures for a definite period of time; 10 minutes for cream and 5 minutes for milk. This necessitates the use of a water bath, and we have required the operators of cream or milk tests to use these water baths in reading their tests.

We believe that the success we have had in Indiana in the enforcement of the creamery and testers' license law has been due, at least in part, to the following:

1. By making a very earnest endeavor to instruct operators as to the proper methods of testing, where we have found them inaccurate, and by using the police or revoking power only as a last resort.

2. By making an effort to secure very authentic and complete data when an operator's license is brought before the examining board or when evidence is collected for prosecution.

3. By receiving the approval of the examining board for revoking a license. This has been of great assistance in establishing confidence in this law. The men engaged in the dairy industry who have served on the board are unanimous in their support of the creamery and testers' license law of Indiana.

4. By making every effort to give the creamery field superintendents and operators of the Babcock test complete instructions on the requirements of the law through short courses held at Purdue University.

Chairman FLANDERS. Before opening this paper for discussion, I will ask if anyone is here to present Doctor Savini's paper? There is no one here to present that paper.

The next paper is one that has been added to the program. It is, "Uniform nomenclature and standards of quality as applied to butter," by M. A. O'Callaghan, dairy expert of the Commonwealth, Melbourne, Australia. Is Mr. O'Callaghan present? He is not here.

This will be a closing of the papers generally. The meeting is now open to your wishes, gentlemen, as to the discussion of any question that has arisen. What is your pleasure?

Mr. F. W. BOUSKA (American Association of Creamery Butter Manufacturers, Chicago, Ill.). I wish to make some remarks on this interesting question of the nomenclature of cheese. It was not clear from the discussion which has occurred whether it was principally from a technological point of view or from a legislative point of view. It appears to me that the best view for us to take is a technological view. I can speak only as a cheese technologist. If what I say is to have any effect in some other country outside of the United States, it will have to be as the words of a cheese technologist. I could not exert my influence upon the legislation in some other country. I therefore believe that our best hope is to form a unity of technical opinion.

I believe there are a number of people in Syracuse this morning who, when they arose, stepped on an Axminster rug, washed with Castile soap, wiped their faces with a Turkish towel, had for breakfast Wiener sausages, Vienna bread, Boston coffee. At the noon meal they ate Boston baked beans, cottage cheese, not made in a cottage, brick cheese not made in a brickyard, and ate in a building made of Portland cement, and so on.

Now we can express a technological opinion. We can not compel the courts in our various countries to apply this opinion. There exists in the American courts a custom. Due to the well-accepted custom in naming, of which I have given you examples, it is not a violation of any law here, and there is no deception in selling a Turkish towel not made in Turkey, Castile soap not made in Castile, and Boston coffee or Boston baked beans not made in Boston. The courts believe that in selling those products under those names there is no deception either in intent or in effect, and, therefore, there is no wrong done.

In the United States laws exist which we believe give full protection to your foreign cheeses. To my knowledge they are well enforced. We hope to live up to the idea of fair play. If any of your foreign cheeses here in America do not get just treatment, we want to know it, and I will assure you that I will do all I can on my part, personally, to give you just treatment here in America.

Now the important question in this country in court procedure regarding the use of these names, is whether there was deception with intent or in effect. It is so much a question of particular facts that it is very hard to deal with in a general way.

In closing, I want to again express my sympathy and assure my cooperation in these efforts to technologically bring about a better understanding of the names of cheeses, and I hope that by such

consensus of opinion among the technologists there will be some sort of custom established that will be the foundation of legislation. If we technologists can not agree among ourselves, we can not hope the legislators or the law-making bodies and courts, who know nothing about cheese, to take decisive action.

As I said, in my opinion we have laws here that give adequate protection. A belief prevails at this time among many that we have had in the United States too much legislation. According to reports in the United States at the present time, 19 citizens are supporting 1 citizen in Government service. If we are going after these men who do something wrong in connection with butter and cheese, and so on, we will have to have more men in Government service, more taxation, 18 of us will be producers and taxpayers and 2 will be living on those taxes and watching us to see that we don't do wrong. By and by, 17 of us will be taxpayers. There is considerable opinion that we have already gone too far in that direction, and more and more we are inclined to proceed along the lines pointed out to us a few days ago by Governor Pinchot, of Pennsylvania. We would rather depend on the ideals and sense of justice within the industries to keep things right.

Chairman FLANDERS. Ladies and gentlemen, the papers that have been discussed and on which further discussion was deferred until the end of the program, can now be discussed. It has been suggested to the chair that some of the members have come long distances from foreign countries, that they don't meet with us very often, and that they would like to discuss some of these questions further. It seems to the chair, out of courtesy to these people, that those points which they want to discuss should be opened up now.

Mr. J. J. FREY (California). If this congress is going to be a true congress, I believe we should have discussion; otherwise we should arrange for an international exchange of papers. I would like to see those gentlemen given an opportunity to discuss, exhaustively, those matters of vital interest to them, and I move that we have a discussion at this time.

Chairman FLANDERS. The discussion was postponed merely to close the papers. The papers have all been read where the representatives have been here to read them, and if any of you gentlemen have any questions to raise, please do so now.

Prof. A. PETER (Switzerland). We have had here to-day a number of very interesting reports by men of different countries, and we are aware that some of these questions are not very clear and are not yet very uniform. It would be of great value to discuss those questions more extensively and more decisively. I believe that can be done by an international cheese commission. We have, as you know, the International Federation of Dairying, a number of the delegates here being members of this federation. Some very important countries are not yet members. It would be of the greatest value to have this question settled as soon as possible. I think it would be best to have an international cheese committee. This committee may consist of members from each individual country. It would be of great importance if the United States would be a representative of this committee. I think it would be well to have Doctor Swaving take charge of this proposal and invite the United States Department of Agriculture to be a member of this international cheese committee.

If you agree to my proposal, I think Doctor Swaving, who has done a great deal of work along this line, and to whom we are especially indebted for the collection of information relating to legislative matters concerning cheese, should take charge of this committee and take the first steps in its formation. Doctor Swaving could invite all interested countries to name delegates to this committee. He may also invite the United States Department of Agriculture to assign a delegate to this committee.

Chairman FLANDERS. Are there any others who wish to give an expression of opinion or ask questions?

Doctor SWAVING. Professor Peter asked me to invite the representatives of the different countries to give the names of their delegates to the committee he has proposed. So I take the liberty to address the United States and refer to the words spoken by the Secretary of State at the opening meeting at Washington. He pointed out that this congress should offer opportunity to discuss and exchange ideas. He expressed the opinion that international cooperation would be of the greatest importance to the international commerce and dairy interests. I take the liberty of addressing Mr. Frisbie, who is the representative of the Bureau of Chemistry, and I wish to state that several countries—all of which are not represented here, but I would name Denmark, Norway, Sweden, Switzerland, and Holland—would agree to this proposal of Professor Peter's. I ask you if on your part you would be a member of that committee. This committee would at this time be an informal one. It would not have many formalities, but its purpose would be to do something. Now that we are together here, it is possible to take this work up. May I ask you if there is any objection on your part to being a member of this committee?

Mr. FRISBIE. I should like to say, as a word of explanation, that I have not been officially designated a representative of the Department of Agriculture. Doctor Redfield and I are official representatives of the Bureau of Chemistry, a bureau in that department. As far as being a member on any committee, particularly an informal committee, I could say for myself, and I think also for Doctor Redfield, that if we could be of any value we would be most happy to participate in your deliberations, assuming it is understood that it is entirely informal, that we would not be clothed with authority to represent the United States Department of Agriculture.

I understand Secretary Wallace is to be here to-morrow; and if, before this congress adjourns, it is the desire that such a committee be formed, in order that international standards may be given official recognition within the department, it could be presented to Secretary Wallace. But so far as any informal conference dissertation is concerned, I am sure we would be happy to do all we can so far as the Bureau of Chemistry is concerned.

Mr. CASSOU. Before proceeding with the question of a committee, I think that committee could only do useful work if it consisted of people really given power by their governments to effect some regulations. This committee would be laying the basis of an international nomenclature. As I said before, some of the countries

most interested in the question are not represented here. I mean, for instance, Italy, which is a big exporter of cheese to America.

I do not really see how we could do useful work. France is an exporter of a few products, such as Camembert, Roquefort, a little Pommel. While we are producers in France, and our Government is a representative of those producers, we would not be able to be represented in the committee. Our representative, Doctor Porcher, is going back to France this afternoon. I am not an official delegate, and my business calls me back also to New York.

The World's Dairy Congress has an international world organization, a good organization, already existing. The best thing would be to put the question before the president, Professor Van Norman, who could then send official invitation to the various countries interested, as has been done for the World's Dairy Congress. As most of these countries are European countries, a meeting could be arranged between them, and all the parties interested would have full notice and could gather the necessary information and useful discussion on the question. Then the Bureau of Chemistry of the United States could also receive notice, and the representative of the Bureau of Chemistry could attend the meeting if it were decided upon. But, actually, I do not think any good could come if the people interested are not all here.

Doctor SWAVING. The proposal which was made by Doctor Peter has for its object a beginning. You spoke of France and Italy. We shall be glad if France and Italy will appoint delegates to serve on this commission, but if we wait until we are all together it will take too much time and we will arrive at nothing. What we want to do now is to take the first step.

As regards the Bureau of Chemistry and the Department of Agriculture, I think their coopération will be given. We should not consider formalities too much. The question is whether we are going to do something; and when you personally are convinced of the importance of such a committee, then there should be no objection as to formality. Later on, when the question is brought before the governments officially, these questions can be put in the right way.

I would say this, and it is also the meaning of Professor Peter, we are here to-day, three or four or five countries together; we can start it, and by and by we will get the others.

Mr. CASSOU. How can you go and have even a preliminary meeting when you have no delegate here who knows the Italian industry? How can you get a representative of the French industry? I am not a representative of the French industry. I am indeed concerned privately with the Gervais, but I am not qualified to attend that meeting. Professor Porcher, who would be qualified, is not able to attend. This is why I propose that if a meeting is to be held it should be held in the regular way. Professor Porcher has already exchanged views with me about the matter. He considers a meeting now would be absolutely of no use. As I am not directly interested in the question, my remarks are from a purely objective point of view. There are some kinds of cheese Doctor Swaving mentions from countries not represented here. How can you discuss this without the authority of the leading people of the countries of origin? That is why I consider that if some useful work is to be done which will lead to

international regulations it can only be done when accredited representatives of all countries concerned can attend the meeting.

Doctor SWAVING. I know many people in Europe; I know many people in France, in Belgium, Italy, and other countries. It is my belief that when we get this committee started we will get the others to come in. You know we have already had some meetings in Berne, Switzerland, Christiania, Copenhagen, and there we discussed the matter. Before the war we had a study committee. Many people of Europe were on that committee. We not only discussed cheese, but other matters. I make this proposal in the name of the five countries mentioned above.

You say in regard to Italy and France no representatives are present. It does not matter. They will come to us. But the people that are present now could meet to-day or to-morrow and discuss what we are going to do further. I think there could be no objection to that. Later on we could have formal meetings, as you want them. But if we postpone the idea and put it before Professor Van Norman, although it would be in very good hands, I think it would take a great deal of time. I think it is better we proceed as we did last year, but we should like to have other people with us, and when America has joined the association there would be no objection if the dairy association took up the matter.

Mr. CASSOU. It is not a question of objecting to the meeting, but a question of what kind of a meeting can we hold now. I do not believe we could do more than we could do in talking in the corridors or lobbies of the hotels.

Mr. BOUSKA. Doctor Swaving has come all the way across the sea to express his ideas to this congress on this important subject. I appreciate that. He has a plan in mind, and I am glad that he is willing to do something. I rather think his plan is a good one. I am willing to trust to him that his plan is a good one. I have no fear that this committee that Doctor Swaving proposes would attempt to define how American cheeses are made and what their qualities are at a meeting at which the American members of this committee are not present. I do not have any fear that Italian cheeses will be defined, and so on, at meetings at which Italian representatives are not present. And I am in sympathy with the energy of Doctor Swaving to go ahead and do something. I am willing to trust to his good judgment in undertaking something in this important subject. I have no fear that he will do something wrong.

Mr. A. POOLE WILSON (chief inspector of dairying, Dublin). Doctor Swaving appears to be on the study committee of the old International Federation. I think that if the work as it was carried on before the great war were continued, with the assistance of all nations represented, we could speedily come to international standards, nomenclature if you like, composition if you like, which would not interfere in any way with the technique of the processes at home.

Now the informal meetings do not appeal to me. A government does not like to send its representatives to informal meetings which have no weight and which do not lead to anything. It is an expensive matter, especially for the smaller countries who have to send some one over here or long distances on the Continent. I think you wealthy people here might easily send a dozen or so to Europe.

The point that I would like to put is this: That either from the World's Dairy Congress or from the old International Federation of Dairying a formal invitation should be sent out to each country, asking them, first, to send a representative who would be prepared to come to a decision, to make recommendations, or to fall in with recommendations for his particular country. For instance, there would be discussion as to the composition of Cheddar cheese. That is made all over the world and forms a great part of the cheese of the world. Who is to settle the original composition? Shall it be the little village where it originated or the biggest manufacturer in the world? These matters will all have to be submitted, and questionnaires should be sent out as a basis for further discussion by the representatives.

That questionnaire could be discussed by the various departments represented, and the line of action which they are desirous of taking could be formulated before the representative leaves the countries, with more or less elasticity as to amendments.

I have heard of two or three meetings on the composition of cheese standards being held in the congress. I have not been asked to one of them, although I am an old member of the federation and I am a present member of the federation. I do not like what you call that informal meeting, which might commit people to decisions which the governments at home might not like.

Therefore, I would say that if this meeting desires something be done it should express the hope that the committee of this World's Dairy Congress or the committee of International Federation of Dairying should issue an invitation to the various countries to send official representatives to the meetings to discuss these points and to lay down definite rules for nomenclature, composition, and so on.

Chairman FLANDERS. Is there anything further on this question, gentlemen?

Mr. PETER. I wish to emphasize my proposal. First, that Doctor Swaving invite the different interested countries to name a delegate to the international commission.

Then Doctor Swaving would put up a program to be studied by the different members of the committee; that he send this program to the members without inviting them to an informal session. Each member studies this program and tells Doctor Swaving what the situation is in his respective country. Later on we will see if a meeting of the whole committee is necessary, or if we can proceed by the means of correspondence. The last thing would be to make up a written paper, to issue a small book which would contain uniform proposals of this committee concerning international regulations of the cheese question. Of course, this proposal would only be a guide. Each country is entirely free to take from this proposal what it will. That is my idea concerning the work that could be done by this international committee.

Dr. F. E. POSTHUMA (president of the board of directors, Netherlands Federation of Unions of Cooperative Dairy Factories). The old International Federation has not, as members, all the countries of the world, mainly not America. We would ask the old federation to invite its members and we would not get farther than we are at this moment. We have discussed the matter from the other side, to put

it in the hands of the president of the World's Dairy Congress, to invite all the representatives of the world who are represented here in the congress. We thought while we were here it would be well to have an informal meeting to discuss a wise course to take. That was the reason for the invitation of Professor Peter in the beginning.

You have spoken of the expense which a delegate would have to incur. We would have no additional expense in connection with a meeting now. Why can't we come together this evening, to-morrow, or Wednesday and have an informal meeting to arrange matters for the future, to arrive at a point where we can go further on and not lose all we have brought before this congress?

Mr. A. POOLE WILSON. I didn't suggest that the International Federation, the old one, should only invite its members. I think that division was a mistake in the past, and I think it should start and invite all countries, but I think an invitation like that should be from some official body of standing rather than from a private individual. That is my own expression of opinion.

Doctor POSTHUMA. Now this informal meeting here at Syracuse is only to find a way out. That is the only demand we make. I know Professor Porcher, and I know the representative of Italy, Doctor Longobardi, and have known them for many years. I am sure if they were here they would agree with us and come to an informal meeting to speak about a way out.

Mr. CASSOU. I do not think we could say any more at an informal meeting than we are saying now, and we will always arrive to that point. In order to accomplish anything useful it must be a meeting as a result of an invitation from some well-organized and well-recognized body. The only organizations which would be effective are the World's Dairy Congress or the International Federation of Dairying.

Chairman FLANDERS. The time for our meeting is past. The chair does not wish to interfere, but to make a suggestion that we have no authority to pass a resolution. Would it not be well for you people interested to get together and devise a means of approaching the executive committee of the organization, suggest what you want, and let them take action, which you could do without passing a resolution here. The chair is only suggesting that for the sake of brevity.

Mr. CASSOU. That was my original proposal, to put it before Professor Van Norman.

Doctor SWAVING. In regard to the proposal that this question be put before Professor Van Norman, that is all right, but I think it would be better that the delegates speak about this matter to Professor Van Norman.

Mr. A. POOLE WILSON. We are quite willing to help in any way we can.

Chairman FLANDERS. Let the chair suggest, for the sake of brevity, that you gentlemen interested place a notice in the hotel asking the representatives of the foreign countries to get together and discuss this question, then take such action as you see fit.

(Adjournment.)

(Papers read by title) :

POUR UNE DISCIPLINE INTERNATIONALE DU COMMERCE DES FROMAGES.

Rapport de la Commission de la Section Italienne de la Fédération Internationale de Laiterie, formée par les professeurs C. Besana, G. Fascetti, C. Gorini, A. Menozzi.]

Giuseppe FASCETTI, de l'Institut Expérimental de Laiterie de Lodi, Italie.

Aucun pays qui produit et qui fait commerce des fromages ne peut pas méconnaître l'opportunité d'un accord international afin de pouvoir arriver à une législation uniforme du commerce de ces produits.

Il n'est pas difficile de s'apercevoir que cet accord est encore plus nécessaire si l'on considère que, tandis que la consommation des fromages s'est sensiblement répandue, l'imitation de différentes espèces de fromages, surtout celles qui ont le plus grand crédit commercial, s'est propagée avec une certaine intensité dans les pays les plus différents et les plus éloignés de ceux qui donnèrent origine à ces mêmes types de fromages développant patiemment leur commerce.

Bien qu'on doive reconnaître à chaque pays sa légitime aspiration de tâcher de produire chez soi les aliments que son peuple désire, le droit des pays qui exportent leurs spécialités de fromages paraît encore légitime au même degré, puisqu'ils ne veulent pas que ces spécialités aillent se mélanger avec l'assemblage des produits d'imitation.

Sans en douter ce problème, dans sa solution internationale, n'est pas sans difficultés, mais nous ne croyons pas impossible d'y joindre l'approbation d'un congrès international par des conceptions claires et peu nombreuses, qui ne contrarient pas beaucoup avec les courants pratiques du commerce; c'est-à-dire, tâchant d'éviter des complications et des obstacles dans les transports et dans les contrôles des fromages.

Cette question fut déjà discutée au Congrès International de Laiterie de Berne, en 1914, dans un rapport illustré par M. le Prof. Swaving de la part de trois nations. Cette question a été traitée de nouveau par la Commission Suisse du Lait dans un mémoire qui fut même envoyé à la Section Italienne de la Fédération Internationale de Laiterie, où l'on formula trois propositions que la Section Italienne examina diligemment, en accueillit les principales idées mais proposant aucunes modifications.

Nous voudrions tout d'abord développer les considérations italiennes sur les propositions suisses qui énoncent enfin les conclusions que nous estimons dignes d'être adoptées par le Congrès Universel de Laiterie de Washington.

Les propositions susmentionnées, qui devraient servir de base à la compilation d'une législation internationale, sont ainsi exprimées:

1. Prescription d'un minimum de matière grasse dans les différentes espèces de fromages et d'une nomenclature correspondante au contenu en matière grasse.

2. Prescription d'un minimum de matière sèche ainsi que de la plus grande quantité d'eau dans les différentes espèces de fromages.

3. Déclaration sur l'origine du fromage.

Dans le commerce l'imposition de la déclaration d'un minimum de matière grasse et le pour cent de la matière sèche du fromage correspond à un jugement commercial théoriquement juste.

Nous croyons cependant que l'on ne puisse pas généraliser ce jugement à la plupart des espèces de fromages, mais que l'on doit et que l'on peut borner à un groupe plus limité d'espèces de fromages, et précisément aux espèces d'une plus large consommation internationale qui sont d'habitude produites avec du lait tout gras, c'est-à-dire : l'Emmental, le Roquefort, le Gorgonzola, etc.

Dans ces fromages qui, par leur diffusion, ont été l'objet d'un contrôle international de la part de beaucoup d'expérimentateurs, les limites les plus grandes et les plus petites où oscille la matière grasse et le pour cent de la matière sèche, étant comprises entre 40 et 50, sont, dans la plupart des cas, très voisines l'une de l'autre.

Dans ces espèces de fromages les oscillations de la quantité de gras, plus que des influences techniques, toujours assez uniformes, sont déterminées par les oscillations de la composition du lait, lesquelles se rapportent au tableau des actions des saisons, de la lactation, de la race, etc.

Ce point convenu, il sera possible d'arriver à un accord international.

Mais pour ces espèces de fromages que l'on fabrique d'ordinaire avec du lait partiellement écrémé d'une ou de deux traites, les différences de la quantité de gras peuvent être très accentuées, car aux influences sur la composition du lait s'unissent les exigences particulières de la technique, lesquelles varient d'une saison à l'autre (degré de maturation, repos du lait, etc.).

Les limites les plus grandes et les plus petites de la quantité du gras dans la matière sèche d'une même partie de fromage, produite dans la même laiterie, peuvent varier entre des chiffres très larges.

Par exemple, dans le fromage grana type de Reggio Emilie, produit avec du lait de deux traites partiellement écrémé, nous avons remarqué des limites variantes entre 29 et 43, tandis que dans le grana type de Lodi ces limites sont de 20 à 35.

Or, il ne serait pas raisonnable d'imposer le moindre limite de 29 pour le fromage grana émilien, tandis que dans la plupart des formes d'une même partie cette limite est supérieure à 35.

D'ailleurs, tantôt pour le producteur tantôt pour le commerçant, il serait difficile, pour ne pas dire impossible, de donner la garantie de la moindre quantité du gras contenu dans le fromage qu'il exporte, même si, en précédence, l'on avait fait le contrôle, du moins que des prélèvements des échantillons sur de nombreuses formes n'eussent pas été faits.

Le même procédé devrait être suivi par les personnes et les bureaux chargés de répéter ce contrôle.

Dans ces cas, il semble plus juste de désigner une valeur moyenne qui pourrait être représentée non pas d'un numéro, mais bien par une diction précise, qui devrait donner un jugement acceptable de la quantité présumable de gras existant dans le fromage.

Il sera alors suffisant d'expliquer le sens de la diction à appliquer aux fromages produits avec du lait partiellement écrémé, en exprimant avec des numéros les fractions du lait qui a reçu la soustraction de crème. Ces dictions pourraient être ainsi : fromage demi-écrémé, fromage de lait écrémé d'un tiers, d'un quart, de deux tiers, etc.

Selon la quantité produite de beurre, le producteur est toujours à même de savoir et de fournir ces chiffres au commerçant afin qu'il puisse les garantir dans ses ventes.

En adoptant ces indications, la discipline internationale du commerce des fromages, depuis longtemps désirée, pourra facilement s'améliorer. On ne rencontrera pas non plus d'oppositions très remarquables chez les intéressés vu cette nomenclature étant déjà en usage dans le langage technique.

Ce qui restera à établir sera le moyen de rendre la nomenclature claire à tout le monde, moyen qui pourrait être l'adoption d'une marque de fabrique, convenue de commun accord, et reconnue officielle et légale par un règlement international.

Sur la proposition de l'indication d'un minimum de matière sèche et de là, respectivement, de la plus grande dose d'eau dans le pour cent du fromage, on observe qu'en réalité dans les différentes espèces de fromages qui sont arrivés à leur maturation la quantité d'eau oscille entre des limites assez voisines. Mais dans les exigences commerciales il arrive que tous les types de fromages ne sont pas envoyés à la consommation à leur juste point de maturation. Il y a eu, au contraire, des types que l'on ne peut pas expédier complètement mûrs, puisqu'ils arriveraient au consommateur à l'état de ultramaturation.

Le commerce du fromage est assez compliqué; parfois une partie de cette marchandise passe par les mains de deux ou trois commerçants avant d'arriver à celui qui vend au détail.

Dans le commerce d'outre-mer, les fromages à pâte dure spécialement, sont expédiés pendant leur maturation à la suite de certains accords de contrat entre les intéressés, et ils arrivent à destination avec une perte qui peut même atteindre quelques kilogrammes.

Il serait donc très difficile de fixer les plus grandes limites d'eau pour les fromages dans un règlement international. Il nous semble que cette question présente une considération plus scientifique que commerciale.

Nous trouvons cependant qu'il serait très utile d'encourager dans chaque pays une telle étude qui fasse connaître les différents types de fromage sous les plus différentes conditions, de productions et les différentes phases de leur maturation.

Cette étude ferait encore connaître le degré relatif de la maturation de chaque espèce de fromage pendant les différentes époques de sa maturité.

C'est pour cela que l'on doit invoquer la connaissance du degré de l'eau des fromages afin de donner des indications utiles au commerce.

A l'égard de la prescription de la déclaration de l'origine du fromage, nous voudrions que tout type de fromage fût caractérisé par l'appellatif de son origine, qui pourrait ne pas être nécessaire seulement que dans le cas où le fromage vint du pays de sa même origine.

On sait très bien que dans le champ de la fromagerie, ainsi que dans celui d'autres produits alimentaires, chaque produit hérite du milieu de production de sa matière première des caractères bien distincts qui se perpétuent sur une certaine région, mais pas ailleurs.

Le même type de fromage fabriqué avec la même technique sur la montagne, ou à la plaine, n'a pas la même valeur commerciale et alors non plus le même prix.

Il y a certains types de fromage qui présentent des qualités vraiment précieuses et que nous ne trouvons pas reproduites dans leurs imitations.

Ainsi, chez la liberté d'imitation on doit aussi respecter et protéger la qualité et les valeurs commerciales de quelques fromages des pays d'origine.

La proposition déjà présentée au Congrès de Berne devrait être résolue par le congrès américain avec cette clause: que la plupart des fromages, étant désigné avec un nom géographique (Emmental, Roquefort, Gorgonzola) qui nous rappellent le pays de leur provenance, on doit exiger qu'au nom d'un type de fromage originaire d'un pays déterminé, ou au nom d'un fromage qui exprime une certaine localité, soit ajouté l'appellatif du pays où on le fabrique (par exemple: Emmental de France, Cacciocavallo du Canada, etc.).

Une semblable indication devrait être imprimée sur les formes du produit, au moyen d'une marque et être aussi imprimée sur les papiers et sur les emballages d'expédition.

En considération des propositions susmentionnées, la commission de la Section Italienne de la Fédération Internationale de Laiterie présente au congrès les vœux suivants:

Le congrès, ayant reconnu l'utilité que le commerce des fromages soit soumis à une discipline internationale, formule les vœux que dans chaque pays, ou dans chaque état:

1. Un minimum de matière grasse dans le pour cent de la matière sèche des fromages fabriqués avec du lait tout gras et de remarquable exportation soit établi;

2. Pour les fromages fabriqués avec du lait partiellement écrémé soient indiquées les dictions qui désignent les fractions du lait qui a été sujet à l'écémage (fromage de lait demi-écémé, de lait écrémé un tiers, ou bien encore du lait écrémé un quart, etc.). Cette diction doit être imprimée sur les fromages moyennant une marque de fabrique reconnue officielle par un règlement international.

3. Les études pour vérifier la quantité d'eau existant dans les différents types de fromages et dans leurs différentes phases de maturation soient favorisées afin d'offrir des indications utiles à leur commerce.

Enfin le congrès délibère:

4. Que l'origine du fromage soit précisée par l'adjonction au nom du type du fromage du nom du pays où on le fabrique.

[Abstract.]

IN BEHALF OF AN INTERNATIONAL CONTROL FOR THE CHEESE TRADE.

[Report of a committee of the Italian section of the International Dairy Federation.]

GIUSEPPE FASCETTI, Experimental Institute of Cheese Making, Lodi, Italy.

The Italian section of the International Dairy Federation has carefully examined the suggestions submitted by the Swiss Milk Commission concerning the important question of an international control for the cheese trade. The suggestions are:

1. Specification of a minimum of fat in different kinds of cheese and of a nomenclature corresponding to the fat content.

2. Specification of a minimum of dry matter and, respectively, of a maximum quantity of water for the different kinds of cheese.

3. Declaration of the origin of the cheese.

The Italian section of the International Dairy Federation does not think that it would be possible to generalize the criterion, though theoretically correct, of the designation of a minimum of butter fat in the great majority of the different kinds of cheese.

The section holds that this should be limited to the small groups of cheeses in greater demand in international trade which are generally made of unskimmed or whole milk.

It would be difficult to apply this criterion in the case of cheeses made with milk of one or two milkings, more or less skimmed, according to the time which it is allowed to stand, and different in the various seasons. In the case of these cheeses, technical factors have greater influence than the composition of the milk. These may lead to wide variations in the proportion of fat to the dry matter of the cheese.

In such cases it seems more just to designate in words, rather than by a number, the probable quantity of fat contained in the cheese under consideration, provided the cheese is technically made in the usual manner.

This could be designated as follows: Cheese from milk one-fourth skimmed, or three-fourths cream; cheese of milk half skimmed, or cheese half cream, and so on.

As to compulsory declaration of a maximum of water contained in the cheese, the quantity of water varies but little. It is frequently found that, due to commercial exigencies, cheeses are shipped at different stages of ripening. Thus it is not an easy matter to guarantee the maximum quantity of water, unless an accurate analysis were made each time of a large number of cheeses.

Under present conditions, knowledge of the quantity of water in cheese is required more for supplying useful information to commerce than for legal purposes.

Regarding compulsory declaration of the origin of the cheese, the Italian section feels that every type of cheese should be distinguished and marked with its origin. This would be superfluous only in the case of cheese coming from the country where that type was originally made.

On the basis of the above considerations, the Italian section of the International Dairy Federation has the honor to submit the following suggestions:

The congress, recognizing the utility of placing the cheese trade under an efficient international control, suggests that in each country or State—

1. A minimum of fat be established in the percentage of dry matter of export cheeses made from whole milk.

2. In the case of cheese made from milk that is partially skimmed, they should be so designated, giving the fractions of the skimming of the milk (cheese of half skimmed milk or one-third skimmed or one-fourth skimmed, etc.).

3. That studies be encouraged for ascertaining the quantity of water contained in each type of cheese, and at the different stages of ripening, to supply commerce with useful information.

4. Finally, that the congress will consider :

That the exact origin of the cheese be ascertained, adding to the name of the type of cheese the name of the country in which it was made.

LE CONTRÔLE DES BEURRES EN BELGIQUE.

C. Huyge, professor à l'Institut Agronomique de l'État à Gembloux, chargé du service de la station laitière, Gembloux, Belgique.

Lorsqu'en 1903 les Pays-Bas créèrent leur contrôle des beurres, cette innovation fut accueillie avec scepticisme; on était d'accord sur le principe, mais on estimait qu'il était irréalisable en pratique. Il fallut toute la patiente énergie néerlandaise pour prouver, et d'une manière éclatante, que l'idée était parfaitement réalisable et capable de procurer à l'industrie laitière des garanties et des avantages énormes. Depuis, le Danemark est entré dans la même voie, aboutissant aux mêmes résultats, mais par des moyens quelque peu différents.

Il serait superflu de démontrer l'utilité du contrôle des beurres; cette question a fait l'objet de nombreux rapports aux Congrès Internationaux de Laiterie de Paris (1905) et de La Haye (1907).

Remarquons, toutefois, qu'on a toujours envisagé le contrôle des beurres comme une mesure précieuse de garantie pour les pays exportateurs de beurre, visant avant tout à donner un certificat d'authenticité et de pureté à un produit important d'exportation. C'est une des faces de la question, et si nous nous permettons de remettre le sujet sur le tapis, c'est pour montrer que le contrôle des beurres est tout aussi utile et intéressant pour les pays producteurs de beurre, mais non exportateurs.

La Belgique se trouve dans cette situation: elle consomme annuellement 64,000,000 de kilogrammes de beurre, alors qu'elle n'en produit que 45,000,000 de kilogrammes; d'où importation forcée de 19,000,000 de kilogrammes de beurre par an (Pays-Bas, Danemark, Australie, Nouvelle-Zélande, République Argentine, Canada, etc.).

Notre déficit en beurre est considérable et la Belgique ne sera probablement jamais un pays exportateur de beurre. Néanmoins, la création d'un contrôle sérieux des beurres indigènes fut décidée il y a 10 ans; l'initiative en revient à la Société Nationale de Laiterie de Belgique.

Pour arriver à un résultat, il était nécessaire tout d'abord de grouper les laiteries en une union professionnelle à statuts entérinés conformément à la loi; dans ce but fut créée, le 4 juin 1913, l'Union Nationale des Laiteries Belges, union professionnelle reconnue, établie à Bruxelles.

L'union ainsi dénommée a essentiellement pour but:

- 1°. De garantir la pureté des produits de ses affiliés.
- 2°. De travailler au progrès et au perfectionnement de leur industrie.
- 3°. De défendre leurs intérêts professionnels.

Comme moyens d'action l'union prévoit la création d'un organisme d'inspection et de contrôle chargé de visiter les laiteries des affiliés, de surveiller la pureté de leurs produits et de donner des conseils techniques.

La réalisation des projets de la Société Nationale de Laiterie et de l'Union Nationale des Laiteries ne put se faire avant 1914. L'idée fut abandonnée pendant les années de guerre et ne fut reprise qu'en 1919. En février 1921, le Contrôle des Beurres Belges était sur pied.

Voici, exposée dans ses grandes lignes, l'organisation du Contrôle des Beurres Belges:

Le Contrôle des Beurres Belges est une adaptation à nos conditions locales du système qui a donné de si brillants résultats en Hollande.

En Belgique trois organismes travaillent de commun accord:

1°. Le Ministère de l'Agriculture: le Gouvernement accorde son patronage à l'institution et autorise l'emploi des armes de Belgique sur les marques de garantie. Il subsidie le contrôle et met à sa disposition la Station Laitière de l'Etat à Gembloux pour l'analyse gratuite des beurres.

2°. La Société Nationale de Laiterie qui organise et inspecte le contrôle et joue le rôle d'intermédiaire entre le Gouvernement et l'union.

3°. L'Union Nationale des Laiteries Belges, dont il a été question plus haut.

Le Contrôle des Beurres Belges est régi par une commission de 10 membres: 4 délégués de la Société Nationale de Laiterie, 4 délégués de l'Union Nationale des Laiteries Belges, 1 délégué de la Station Laitière de l'Etat et 1 délégué du Département de l'Agriculture, ces deux derniers désignés par le Ministre de l'Agriculture.

Un directeur est chargé de l'administration générale du contrôle suivant les indications de la commission.

Le Contrôle des Beurres Belges est facultatif: il n'y a aucune obligation pour les laiteries à se mettre sous contrôle, mais celles qui acceptent le contrôle se créent des obligations, strictes peut-être, mais qui leur sont favorables au plus haut point.

Toute demande d'affiliation fait l'objet d'une enquête menée par les inspecteurs et dont les résultats sont transmis à la direction et de là à la commission qui seule peut donner suite aux demandes. Il va sans dire que pour l'affiliation d'une laiterie, la commission s'entoure de toutes les garanties et se montre d'une grande sévérité. Les règlements de l'organisation sont du reste formels et contiennent une longue série de dispositions précises sur les conditions que doivent réunir les laiteries pour pouvoir être inscrites. Il en résulte que l'admission constitue pour la laiterie une recommandation précieuse.

La falsification du beurre est rendue impossible; elle serait dévoilée soit par la vérification périodique à laquelle est soumise la comptabilité spéciale imposée par le contrôle, soit au cours des visites fréquentes des inspecteurs et des contrôleurs, soit par l'analyse chimique. Aucune tentative de fraude n'a été constatée jusqu'à présent; d'ailleurs, le règlement prévoit des amendes très élevées indépendantes des poursuites judiciaires.

Les beurres sortant des laiteries affiliées doivent être pourvus de la marque distinctive reproduite ci-dessous et dont il existe plusieurs formats.

Ces marques de garantie sont imprimées sur papier mince spécial, elles sont incisées et fortement appliquées sur les mottes de beurre. Il est impossible de les enlever sans les déchirer en menus fragments; par ce fait tout réemploi est rendu impossible.

Chaque marque porte un numéro d'ordre qui permet à la direction du contrôle d'identifier immédiatement l'origine d'un beurre contrôlé et de déterminer sa date de fabrication. C'est en somme tout le système néerlandais que nous avons adopté dans les grandes lignes, avec quelques modifications imposées par les particularités de l'industrie laitière belge.

Le contrôle du travail des laiteries est assuré par les contrôleurs et les inspecteurs, de la manière suivante:

Le contrôleur arrivant dans une laiterie s'occupe tout d'abord du beurre en cave, qu'il note soigneusement par catégories d'après les formats des marques, donc le poids des mottes. Passant ensuite au bureau de la comptabilité, il y ajoute les marques de chaque format renseignées dans le livre de vente depuis sa dernière visite. Ce travail terminé, il examine les carnets de marques et trouve par différence les marques de chaque format utilisées depuis sa dernière visite. Les nombres ainsi trouvés doivent correspondre exactement aux totaux obtenus en additionnant les marques du livre de vente et celles du beurre en cave.

Toute négligence dans la tenue du livre de vente imposé par le contrôle, expose à des amendes et même à la radiation temporaire ou définitive du membre. Celui-ci peut toutefois se pourvoir en appel devant une commission spéciale jugeant en dernier ressort toutes les peines infligées par la commission du contrôle.

Chaque visite du contrôleur donne lieu à un rapport écrit signé par le contrôleur et le directeur de la laiterie; ce dernier peut y joindre ses observations. Les rapports sont transmis à la direction du contrôle.

La visite de contrôle implique le prélèvement des échantillons, de préférence dans la masse de beurre quittant le malaxeur. Les échantillons sont envoyés le jour même à la Station Laitière de l'Etat à Gembloux.

Chaque laiterie est visitée au moins deux fois par mois, à jours indéterminés.

Les inspecteurs sont chargés des enquêtes préliminaires dans les laiteries qui demandent l'affiliation, de l'inspection des laiteries sous contrôle, de la surveillance et de la direction du service des contrôleurs, des visites aux laiteries qui leur sont signalées par la station laitière pour leur production défectueuse ou pour tout autre motif. Ils prélèvent des échantillons dans des laiteries et aussi dans les dépôts, maisons de vente, et autres lieux où ils trouvent du beurre contrôlé.

La Station Laitière de l'Etat à Gembloux assure le contrôle chimique des beurres. Elle reçoit les échantillons prélevés par les inspecteurs, les contrôleurs et aussi ceux envoyés spontanément par les laiteries.

L'analyse courante porte sur les points suivants: l'eau, l'indice d'acides gras volatils et l'indice de réfraction. Les beurres sont aussi examinés aux points de vue suivants: odeur, saveur, texture de la pâte, conservation.

Les déterminations: acides gras volatils et indice de réfraction ont pour but de fixer les caractères physico-chimiques des beurres des différentes laiteries et d'établir pour chacune d'elles des courbes annuelles qui seront précieuses pour l'avenir. En outre, ces déterminations servent à renseigner sur les falsifications éventuelles.

Le contrôle attache une grande importance à la teneur en eau des beurres. Il estime avec raison qu'elle constitue le meilleur critérium de la qualité du travail d'une laiterie. Le contrôle tolère au maximum 16 pour cent d'eau dans le beurre, et chaque fois qu'une laiterie dépasse cette limite la station laitière lui adresse un avertissement en même temps qu'elle informe du fait l'inspecteur de la circonscription.

Quand un adhérent, après avoir reçu deux avertissements consécutifs dans un délai de 15 jours, livre ou expédit du beurre contenant plus de 16 pour cent d'eau, il lui est appliqué une amende égale au pourcentage d'eau dépassant 16, calculé en beurre, pour la production et sur le prix moyen du mois en cours, avec minimum de 100 francs.

L'examen des registres d'analyses permet de ranger les laiteries en trois catégories:

1°. Les laiteries à travail régulier: le pourcentage d'eau du beurre est pratiquement constant pendant toute l'année.

2°. Les laiteries à travail irrégulier: le pourcentage d'eau du beurre subit des fluctuations grandes et incessantes.

3°. Les laiteries à travail anormal: où il est impossible d'obtenir d'une manière régulière du beurre à moins de 16 pour cent d'eau.

Les laiteries de cette dernière catégorie constituent l'exception; elles doivent du reste disparaître du contrôle si elles ne prennent les mesures nécessaires pour améliorer leur travail. Les laiteries de la deuxième catégorie étaient les plus nombreuses au début, mais sous l'influence tenace du contrôle, leur travail s'est régularisé et la plupart d'entre elles passent dans la première catégorie.

Pour terminer cet exposé rapide de l'organisation du contrôle belge, un mot des ressources dont il dispose pour couvrir les frais (administration, traitements du personnel, confection des marques de garantie, des registres, publicité, propagande, etc.).

Les ressources actuelles du contrôle sont constituées par les subides que le Gouvernement accorde à l'œuvre et ensuite par la quote-part payée par les laiteries, d'après l'importance de leur fabrication: 5 centimes par kilogramme de beurre produit. Cette redevance sera réduite dans la suite, au fur et à mesure des possibilités, c'est-à-dire, de l'extension du contrôle.

RÉSULTATS OBTENUS.

La guerre a laissé la Belgique dans une situation difficile qui se répercute dans tous les domaines de l'activité nationale.

Sur 950,000 vaches laitières en 1914, on en retrouve environ 600,000 en 1918. Actuellement notre cheptel laitier est remonté à 800,000 têtes. Le progrès est notable, mais il manque encore 150,000 vaches pour refaire le peuplement de 1914 et environ 400,000 vaches pour faire face à la consommation du beurre dans le pays.

Des 1,000 laiteries que nous possédions en 1914, 470 survécurent à la guerre. Ce nombre se maintient à peu près constant: quelques disparitions dans certaines régions et d'autre part création de quelques laiteries nouvelles dans d'autres régions, selon le jeu des conditions économiques difficiles et compliquées dans lesquelles nous nous débattons.

En 1914 les laiteries absorbaient 20 pour cent du lait produit dans le pays. Ce taux est descendu à 10 pour cent en 1918; actuellement il est remonté à 12 pour cent environ. La régression de la fabrication du

beurre à la ferme s'accroîtra à mesure que la situation de la Belgique redeviendra normale.

Parmi les 470 laiteries en activité dans le pays, il faut compter 295 laiteries à bras; petites laiteries locales, pour lesquelles le contrôle des beurres n'offre pas grande utilité pour le moment. Ces petites laiteries ne sont pas toutefois négligées par le contrôle qui s'efforcera de les fusionner en laiteries plus importantes et mieux outillées dès que la création des laiteries centrales exigera des capitaux moins considérables.

Les quelques 175 grandes laiteries (traitant de 2,000 à 15,000 litres de lait par jour) sont plus intéressantes: les meilleures d'entre elles et les plus importantes furent acquises au contrôle dès la première année; les autres suivent peu à peu.

Fin 1921, le contrôle comptait 30 laiteries, avec une production totale de 585,000 kilogrammes de beurre.

Fin 1922, le nombre des laiteries affiliées était de 42, avec une production totale de 933,000 kilogrammes.

Pour la fin de l'année présente, nous prévoyons 60 laiteries affiliées avec une production approximative de 1,450,000 kilogrammes de beurre.

La progression du contrôle est lente; ce fait est imputable pour une large part à l'état très anormal du marché du beurre. En outre, la direction du contrôle a voulu débiter avec prudence et circonspection; elle s'est montrée très difficile pour l'admission des laiteries; beaucoup ont été refusées à plusieurs reprises pour différents motifs: outillage insuffisant, travail défectueux, incompatibilité avec les statuts et règlements du contrôle, etc.

Le Contrôle des Beurres Belges est né pendant une période exceptionnellement défavorable au développement d'une œuvre de ce genre. Malgré cela il a réalisé, lentement mais sûrement, la première partie de son programme d'action: grouper sous son égide les meilleures laiteries du pays et faire apprécier leurs produits à leur juste valeur par le consommateur en offrant à celui-ci de précieuses garanties.

Nous voulons travailler au progrès de l'industrie laitière en faisant l'éducation du consommateur, car c'est par son intermédiaire, par ses exigences, que nous voulons arriver aux buts poursuivis par le contrôle et que nous résumons comme suit:

Pour les laiteries: améliorer la qualité des produits, perfectionner le travail, assurer une vente régulière, rendre le marché du beurre plus honnête.

Pour les consommateurs: mettre à leur disposition des produits de premier choix, de pureté garantie et leur venir en aide dans la lutte contre la falsification.

La voie adoptée n'est pas directe, elle sera peut-être longue à suivre, mais elle est sûre et c'est la seule praticable dans les circonstances actuelles.

[Abstract.]

BUTTER CONTROL IN BELGIUM.

C. HUYGE, professor at the State Institute of Agronomy, Gembloux, Belgium.

Belgium, although never a butter-exporting country, instituted a system of control for domestic butter in 1921. It was found that this measure afforded a good means for combating fraud and at the

same time was efficacious in promoting, improving, and perfecting the butter industry.

The principles of organization and operation of the Belgian Butter Control are as follows:

Three organizations work together:

1. The Ministry of Agriculture: The Government lends its support to the institution and has authorized the use of its coat of arms for marks of guaranty. It supports the Control and has put at its disposal the use of the Government dairy station at Gembloux for analyzing butters, free of charge.

2. The National Dairy Society, which organized and supervises the Control, acts as an intermediary between the Government and the National Union of Belgian Dairies.

3. The National Union of Belgian Dairies, consists of a professional union recognized by law; dairies affiliated with the Control.

These three organizations are represented by a commission that governs the Control.

The Belgian Butter Control is optional. All petitions for affiliation are subject to very severe examination as the dairies are required to satisfy a long series of distinctly defined conditions for regulation that is designed to prevent falsification as to quality, etc.

The butters coming from the affiliated dairies are given a distinctive mark of which there are various kinds. These guaranty marks are printed on a special kind of thin paper. They are cut and pressed upon the rolls of butter. It is impossible to remove them except by tearing them off in small pieces, and so it is impossible for them to be used twice. Each mark bears an order number which affords the Control an immediate identity both as to the origin of the butter and the date of its manufacture.

Regulation of the methods used by the creameries is assured by comptrollers and inspectors. The former occupy themselves with the verification of the usage of the marks of guaranty, auditing and inspecting the accounts specially prescribed by the Control, and testing the gauges used in the creameries visited. The inspectors are charged with the preliminary examinations in the creameries petitioning for affiliation, inspecting the creameries under the Control, surveillance and direction of the work of the comptrollers, and visiting creameries that are designated by the dairy station as producing defective butter (or for other reasons). They examine the instruments used in the dairies as well as those used in the depots, commission houses, stores and other places where butter control is necessary.

The dairy station at Gembloux assures the chemical regulation of the butter: water content, index of the volatile fatty acids, index of refraction, etc.

The Control attaches a large importance to the water content of butter, estimating, and quite correctly, that this affords the best criterion for the quality of the work of a dairy. The Control permits a maximum of 16 per cent of water in the butter, and each time that a creamery exceeds this limit the dairy station sends the creamery an announcement to that effect and, at the same time, informs the inspector of that district.

The infringements are penalized according to the regulations.

The income and maintenance of the Control depends upon Government subsidy and a contribution made by each creamery in proportion to the size of its output.

The Control was initiated during a period extremely unfavorable for the development of a work of this kind. In spite of this, slowly but surely, the first part of the program was achieved, that was, to bring under its protection the best dairies in the country and to make their products appreciated at their real value. This, as a nucleus, did much to influence other creameries and moreover, the consumers. This intervention, on the part of the consumers, counted for much in attaining the aims which we summarize as follows:

For the creameries: To improve the quality of the products, to perfect the methods, to assure a regulated trade, to make the butter trade more honest.

For the consumers: To put at their disposal products of the first grade and guaranteed purity, and to enlist their assistance in the suppression of fraudulent practice.

L'INDICE ACÉTIQUE DANS L'ANALYSE DES BEURRES.

ELIA SAVINI, Ph. D., de l'Institut Expérimental de Laiterie de Lodi, Italie.

Les adultérations avec des gras étrangers que l'on fait habituellement au beurre sont: l'addition du gras de coco et de margarine, addition qui était faite séparément et qu'à présent on essaye de les mélanger.

Les déterminations que l'on effectue généralement, pour découvrir la fraude des gras étrangers, sont (1) l'indice de réfraction; (2) le titre des acides volatiles solubles dans l'eau (titre Reichert-Meissl-Wollny); et (3) le titre des acides volatiles insolubles dans l'eau (titre Polenske).

Ces déterminations donnent des résultats nets, mais sans sollicitude, pour les beurres adultérés avec de grandes proportions de graisses étrangères (notamment de coco); mais quand les proportions de l'agent adultérant sont inférieures à 10 pour cent, les valeurs de ces adultérations sont imparfaites et pas toujours réelles, de manière que l'analyste reste perplexe.

Cette perplexité peut se changer en erreur quand le beurre a été additionné d'une façon convenable de coco et de margarine. On comprend alors, comme il est nécessaire et très utile de rechercher des moyens qui peuvent venir en aide à l'analyste pour découvrir ces fraudes.

La détermination de l'indice acétique donne à la question une contribution valable et rapide en même temps.

J'ai pu le constater dans les nombreuses analyses que j'ai faites et il vient en aide, spécialement dans les cas incertains et dans les communes déterminations qui sont indécises, à cause d'une minime quantité de gras étrangers ajoutés au beurre (surtout coco et margarine).

Les substances grasses sont toutes facilement et complètement solubles dans l'éther, dans le chloroforme, dans le tétrachlorure de carbone, dans l'essence de térébenthine, dans l'huile de paraffine, dans la benzine, dans l'éther de pétrole, de sorte que ces dissolvants ne peuvent pas donner une méthode d'identification.

Mais, au contraire, apparaît différemment le procédé des gras en présence de l'alcool et de l'acide acétique. C'est justement sur ces réactifs que se basent deux méthodes appliquées à l'analyse des matières grasses:

L'indice Crismer, ou température de solution, qui a pour dissolvant l'alcool à la densité commune, et l'indice Valenta qui se sert de l'acide acétique glacial.

C'est sur les concepts de ces méthodes que se base la détermination de l'indice acétique, étudié et proposé par G. Fascetti et largement expérimenté par moi-même dans les analyses des beurres pour les recherches des falsifications.

Pour rendre possible et applicable la méthode de l'indice acétique, il ne suffit pas seulement de toujours opérer avec un acide d'une densité et d'une concentration déterminée, mais aussi il faut déterminer sur l'échantillon du gras le contenu des acides gras libres.

On effectue alors la détermination de la manière suivante:

Dans une éprouvette ordinaire en verre épais et bien essuyée, on introduit moyennant une pipette un centimètre cube du gras en question, auparavant dissout et filtré; puis, sans faire toucher les parois de l'éprouvette, on laisse tomber goutte à goutte d'une autre pipette 4 centimètres cubes d'acide acétique à 98.5 pour cent. On ferme l'éprouvette avec un bouchon de liège percé d'un trou à travers lequel passe un thermomètre gradué au cinquième ou au demi degré.

On introduit à son tour l'éprouvette dans une autre plus grande, contenant de l'eau où elle demeure fixe moyennant un cercle de gomme ou de liège.

On émerge le tout dans un bain d'eau que l'on réchauffe, on agite de temps en temps délicatement.

Au commencement, la solution du gras et de l'acide se trouble intensément, puis au fur et à mesure que la température augmente, le troublement diminue jusqu'à ce que le liquide devient rapidement limpide.

On lève alors l'appareil du bain, on agite lentement pour qu'il refroidisse un peu et l'on note la température à laquelle la solution commence à se troubler de nouveau.

Pour deux fois on répète l'essai, émergeant encore l'éprouvette dans le bain, ensuite on la lève et l'on répète la lecture de la température au commencement du nouveau troublement; la lecture doit s'accorder avec les précédentes.

Avec un peu d'habitude on peut éviter l'usage du tube de revêtement de l'éprouvette.

De cette manière on peut faire rapidement de nombreuses déterminations en peu de temps sur divers échantillons. L'acide acétique dont on se sert doit être très pur.

Afin que la séparation entre la température de solution du beurre pur, de coco, de la margarine soit supérieure, il faut hydrater l'acide choisi de manière à rendre le titre à 98.5 pour cent en poids d'acide acétique, correspondant à une densité de 1.059 à 15° C.

Avec cet acide l'indice acétique oscille entre 64-66 pour le beurre frais et pur.

Ces oscillations ont été contrôlées pendant longtemps, avec du beurre fait à l'Institut Laitier de Lodi.

Au contraire, l'oscillation est de 30-34 pour le coco et de 112-114 pour la margarine.

En même temps que la détermination de l'indice acétique, on doit faire sur le beurre la détermination des acides gras libres ou la détermination de l'acidité, surtout pour le beurre vieux et rancé dont l'acidité est en proportion inverse de la solution du gras.

L'essai peut se faire avec 2 centimètres cubes de beurre fondu et filtré, ensuite dissout dans 20 centimètres cubes d'une solution d'éther et d'alcool en parties égales.

On titre avec une solution de soude alcoolique normale $\frac{1}{20}$, auparavant additionnée de quelques gouttes de phénolftaleine, jusqu'à ce qu'on obtient une coloration rose.

En indiquant par N le numéro des centimètres cubes d'alcali nécessaires, la température (T°) de la solution du gras sera de $T + N = IA$ (indice acétique corrigé).

En mettant en comparaison la donnée de l'indice acétique avec les autres déterminations, on observe une liaison soit avec la valeur de l'indice de réfraction, soit avec le titre de Wollny, ou de Polenske.

En comparaison de ces déterminations, celle de l'indice acétique résulte plus sensible pour découvrir les fraudes faites dans les proportions inférieures à 10 pour cent.

On comprend comme dans les mélanges où le coco fait part, la valeur de l'indice acétique diminue, tandis que dans ceux où la margarine est présente la même valeur augmente.

Résumant, je remarque les conclusions suivantes obtenues par la pratique de centaines de déterminations faites sur des échantillons de beurre pendant plus d'un an d'essai. Cette détermination donne un avantage très important pour juger sur la pureté plus ou moins grande d'un beurre, même aussi lorsque les déterminations ordinaires ont été faites.

Pour les beurres frais et purs l'indice acétique oscille entre 64-66.

Lorsque l'indice acétique est inférieur à 63, cela signifie l'adultération avec de l'essence de coco, et en proportion de 5 pour cent lorsqu'il marque 60-61.

Lorsqu'il est supérieur à 68 (en essence de coco), il signifie l'adultération avec de la margarine; et en proportion de 5 pour cent lorsqu'il marque 70 environ.

[Abstract.]

THE ACETIC INDEX IN THE ANALYSIS OF BUTTER.

ELIA SAVINI, Ph. D., Experimental Institute of Cheese Making, Lodi, Italy.

The adulterations of butter with foreign fats, which are constantly being made, consist of the addition of coconut and margarin fats, additions formerly made separately, but which it is now endeavored to combine.

Fats are all easily and completely soluble in ether, in chloroform, in carbon tetrachloride, in carbon disulphide, in turpentine, in paraffin oil, in benzol, and in petroleum ether. These solvents, therefore, can not furnish a method of identification. However, the effects of alcohol and of acetic acid on fats are very different. It is, in fact, upon these reactions that two methods for the analysis of fats are based: The Crismer index, or temperature of solution, its solvent being alcohol of known density; and the Valenta index, which uses glacial acetic acid. The determination of the acetic index is based on

these methods. It has been suggested by Professor Fascetti and extensively used by me in the analyses of butter, to find the presence of foreign fats added to it.

In order to make possible and practical the method of determination by acetic indication, it is necessary not only to work with an acetic acid of a definite density and concentration, but also to determine from the sample of fat the content of free fatty acids.

The determination of the acetic index is then obtained in the following manner: In an ordinary test tube, of strong glass and well dried, 1 cubic centimeter of fat under examination is introduced by means of a pipette. The fat is previously melted and filtered. Then, without touching the sides of the test tube, 4 cubic centimeters of acetic acid of a definite concentration are introduced by another pipette. The test tube is closed by means of a cork having a hole in it. Through the hole a thermometer graduated to one-fifth or one-half of a degree is placed. The test tube in turn may be introduced into a larger one about two-thirds filled with water, and fastened in it by means of a rubber or cork ring. The whole is placed in a water bath, and heat is applied. The tube should be shaken gently from time to time. The fat and acid solution, very turbid at first, becomes less so as the temperature rises, and finally becomes clear sharply. The device is then removed from the bath, shaken slowly to cool it a little, and observation is made at what temperature the solution begins to become turbid again. Simultaneously with the determination of the acetic index, one should determine the free fatty acids, or the acidity.

Indicating by N the value of the acidity, and by T the temperature of solution of the fat, the corrected acetic index will be T plus N .

The determination of the acetic index is a valuable aid in judging whether butter is pure or not, even after the usual tests have been made, bearing in mind that in the case of fresh and pure butter it varies from 64 to 66, with an average of 65.

An acetic index below 63 is a sign of adulteration with coconut fat; and this amounts to about 5 per cent when the index varies between 60 and 61.

In order that the acetic index may give valuable results, it is necessary to carry out the test in the manner I have indicated and determine the acidity of the butter, especially if the latter is not fresh. This value will be summed up with that of the acetic index as a basis of judgment on the corrected acetic index.

The determination being an easy and rapid one to execute, it may serve to establish a fairly accurate estimate with rapidity; while determinations by means of the Wollny and Polenske tests require a longer period of time.

UNIFORM NOMENCLATURE AND GRADE STANDARDS OF QUALITY AS APPLIED TO BUTTER.

M. A. O'CALLAGHAN, dairy expert of the Commonwealth, Melbourne, Australia.

My object in bringing this matter up for discussion is to facilitate the international commerce in butter.

We have reached the stage when we might say that almost every country of any note is either an importer or an exporter of butter

and hence the advantage of universal standards and names of standards, not only as regards chemical composition but also as regards quality. Away back in history, butter was simply butter regardless of quality, and in the off-producing season man had to take what he could get. Now, thanks to the control of temperatures as a result of scientific refrigeration and cold storage on land and sea, butter of the very highest quality may be transferred from one side of the globe to the opposite without that valuable commodity undergoing any serious change in quality, and man may now have butter of the very highest quality (24 carat) for his breakfast on any day of the year. This has led to a large percentage of the world's people being more or less connoisseurs in butter eating. Take Australia—50 years ago she had to depend on heavily salted Irish firkin butter for her main supply. Needless to say, this butter was not of a high quality by the time it reached Australia, after a voyage through the Tropics as ordinary cargo. To-day you can not sell second-quality butter in Australia, the people having become so accustomed to getting the very best creamery butter, with only about 1 per cent of salt—hence we must export all the inferior butter we make, often to the detriment of the reputation of our best. It is evident the time has arrived when it would be to the benefit of all exporters as well as all importers, not to speak of consumers, if we could discuss butter in common terms something like that in which jewelers discuss articles made principally of gold.

Last month I visited a London provision importer's store and there I examined Danish, New Zealand, Australian, French, Dutch, Irish, Esthonian, Argentine, and Liberian butters. I had a similar experience in Liverpool only last week. Now the exporters of these butters all use terms of somewhat different meanings to describe the quality of their goods, and, in turn, the English salesman again employs different terms when describing his goods to the intending purchaser. The Australian speaks of choicest, the New Zealander speaks of first grade and the Canadian describes his best as finest selected, and so on. The English importer, the English salesman, and the English buyer must memorize all these varied terms if he is not to be at a disadvantage, and so it is with the American importer, too, when he is on the market.

Australia grades all butter into classes before it can be exported, and a certificate of quality is issued with each parcel. New Zealand does likewise. Canada has, I understand, also instituted a somewhat similar system, and South Africa is on the same road. These butters are graded just prior to export, and if they are held for any length of time after grading and before export they are reexamined in Australia to see if they are true to grade before export is allowed. (If the importer requests his grade certificates he is thus amply protected.) If even those countries that place frozen butter on British and other markets adopted a common system of nomenclature and grade standards, a distinct step forward would be made. The Australian standards and method of examination are as follows:

1. All farm dairies must pass an inspector in hygiene before a farmer may supply milk or cream to a creamery or factory.

2. All dairy cattle must pass an annual veterinary inspection, and any animals that are manifestly affected with tuberculosis or other diseases must be destroyed.

3. All butter and cheese factories are licensed, and unless they are kept in a proper hygienic manner such license to manufacture and trade is canceled.

4. When butter or cheese is intended for export, notice must be given to a duly authorized inspector, and the goods must be sent to a duly appointed cold store for examination and grading by an official of the Australian Government.

5. All packages containing butter or cheese intended for export must show the date of manufacture and the number of the churn or the vat of cheese, as the case may be.

6. When butter now arrives at the cold store, a box representing each churning is placed before an official inspector for examination. First, he takes a sample for chemical and bacteriological examination, and then he grades the butter into classes signifying quality. Should any butter be found not to comply with the chemical standard, the quality or grade certificate for export is not issued.

7. All packages containing butter must show the net weight and must also state whether the butter is Pasteurized or otherwise. Samples are weighed, and any incorrect weights found are held over for correction before export. The trade description as to Pasteurized is checked by a bacteriological examination, and thus butters made from cream inefficiently Pasteurized are detected.

Our grade standards are as follows:

Choicest, 92 to 100 points, inclusive.

First grade, 90 or 91 points.

Second grade, 86 to 89 points, inclusive.

Third grade, 82 to 85 points, inclusive.

Our chemical standards are:

Water not more than 16 per cent.

Casein not more than 3 per cent.

Salt not more than 4 per cent.

Fat not less than 82 per cent, except to those countries with a lower import standard, when the Australian export standard may be not less than 80 per cent.

A boron preservative to the content of 0.5 per cent is allowed to all countries where such preservative is not forbidden.

I do not say that our quality standards are the best or that our system is yet perfect, but I do think we have reached the stage where a common consideration of the subject is advisable in the interests of commerce, and hence I will explain our standards a little in detail.

In grading or judging for quality the following points are allowed:

	Maximum points.
Flavor and aroma.....	50
Texture which covers body, grain, and freedom from loose moisture.....	30
Condition, which includes color, salting, packing, and covering.....	20
Total	100

It is thus seen that to obtain choicest grade a butter must get a minimum of 42 points for flavor, and it is on this minimum, which may be called X, that we build our foundation. This foundation

must have a truly scientific basis. After grading and examining chemically and bacteriologically as many as 70,000 boxes of butter in a year from various factories and then storing those boxes for an average period of four months, we have come to the following conclusions:

a. All butters which show evidence of decomposition, either of fat or proteid matter, get worse when held in store for three or four months even at very low temperatures. Such butters decompose very rapidly when removed from cold storage.

b. All butters that have been made from efficiently Pasteurized milk or cream and that show no trace of decomposition to the taste or smell (when judged by an expert) will maintain their quality for a period of at least three months, and when allowed to thaw out slowly may be retailed and will maintain a clean flavor until ordinarily consumed.

After four years of experimenting on the storage of mainly Pasteurized butters, beginning with 20,000 boxes and going up to 70,000 boxes, we decided that it was safe to build our foundation for choicest on a butter of a neutral taste and smell, or, in other words, on a fat that had no taste or smell of decomposition and that had been Pasteurized. We called this point in our classification X and gave it a numerical value of 42 points out of a possible 50. This allows the grader sufficient margin for giving due points to butters that, in addition to being free from manifest decomposition, show special advantages such as good bouquet, nutty odor, etc.

Anything falling below X in flavor, namely, anything showing the slightest trace of decomposition of fat, proteids, or even of milk sugar goes into a class lower than choicest. If such faults are very slight we class the butters as ordinary first grade on flavor and award 40 or 41 points. If they are nearly perfect in manufacture they will get a minimum of 90 points or first grade. We do not guarantee the keeping quality of these slightly tainted butters, but many of them keep quite well at low temperatures. However, after four days out of cold storage they begin to show very marked decomposition.

In grading manifestly tainted butters, these are put into second or third grades according to the degree and nature of the decomposition.

Next year we propose to apply a brand to become known as a national brand to all choicest butter exported from Australia. This, it is expected, will further stimulate our factory managers and farmers to do their very best to turn out a high percentage of choicest grade butter and will also prevent misrepresentation on behalf of those desirous of making money by selling, say, 20 per cent, of ordinary firsts or good seconds in a large parcel of alleged "all choices." This marking is following on the lines of Denmark, so it is seen we are moving a little toward a universal system.

SESSION 16. TRANSPORTATION OF MILK.

Honorary chairman, M. A. O'CALLAGHAN, dairy expert of the Commonwealth, Melbourne, Australia.

Chairman, F. A. WILLS, Supplee-Wills-Jones Milk Co., Philadelphia, Pa.

Secretary, T. A. BAKER, professor of dairy husbandry, University of Delaware.

ONONDAGA HOTEL,

Syracuse, N. Y., Monday, October 8, 1923—9.30 a. m.

Chairman WILLS. Gentlemen, the meeting will now come to order. Time is one of the valuable things we have at our meetings, because there is not enough time to discuss the papers after the reading of them. We are a little late in starting, and if we allot 20 minutes to each speaker we will run short at the other end.

We have with us this morning as honorary chairman, Mr. M. A. O'Callaghan, dairy expert of the Commonwealth, Melbourne, Australia. [Applause.]

Mr. M. A. O'CALLAGHAN. Mr. Chairman and gentlemen: I would like to take this opportunity of thanking those associated with the inauguration of this congress and those conducting it for the honor of asking me to act as honorary chairman for this session.

I would like to introduce to you this morning Dr. R. Stenhouse Williams, professor of dairy bacteriology, Reading, England. Those associated with dairying and bacteriology, especially in England, know of Dr. Stenhouse Williams. His work is particularly interesting to us, from the point of view that we have to send our products farther to the markets of the world than any other people. England is the great market for the surplus dairy products of the world, and we send them about 75 per cent of our surplus products. I might state that it is the full consideration of the bacteriological side of dairying that has principally enabled Australia to place on the markets of the world a commodity of the character that has made her familiar not only to England but to America.

Without further entrenching on the time of Dr. Stenhouse Williams, for I might go into the aspects he is to cover in his paper, I will now call on him, and I hope you will give him your attention. Doctor Stenhouse Williams. [Applause.]

Dr. R. STENHOUSE WILLIAMS. Mr. Chairman and gentlemen: Before I say anything further, may I express to you all the very sincere sense of gratitude which every English member feels for the extraordinary kindness that we have received since we came to America. [Applause.]

EFFECT OF TOPOGRAPHICAL CONSIDERATIONS ON THE PROBLEMS OF MILK DISTRIBUTION.

R. STENHOUSE WILLIAMS, M. B., C. M., B. Sc., L. R. C. P. and S. E., D. P. H., research professor in dairy bacteriology, University College, Reading, and A. T. R. Mattick, National Institute for Research in Dairying, Reading, England.

I think perhaps I might start what I have to say to you by telling you of a number of incidents which have happened to us recently. People are beginning to come to us from many parts of the world to ask for our help, which, of course, is a matter of the greatest joy to us, because it helps us to feel we are doing something to advantage.

Quite recently four different types of men came to us; one was from Spain, another from France, a third from India, and a fourth from Holland. They asked us how we were managing our work in the parts of the world from which they came. My associates and I tell them this: "We will be delighted to take you around to the farms in our districts and show you how our farmers are handling their milking and sterilization of their apparatus, and how the milk is then brought from the cow and what is done with it. But we want you to realize at once that the successful carriage of milk, provided that you start it right in the first place, depends upon time and temperature. And it is not possible for us in this country, with the conditions existing here, to dictate to you as to what you should do with your milk."

My reasons for adopting this view depend upon a variety of observations, of which we think at least one might well form a subject of combined investigation between England and America.

Is there an inherent difference between the milk of England and that of America?

I have been led to ask myself this question by two quite different sets of observations.

In the first place Hopkins (1), in his original experiments (1912) upon accessory food substances, demonstrated that the addition of so small a quantity as 2 cubic centimeters of milk to a rat's diet promoted growth to a very wonderful degree. Osborne and Mendel (2), repeating these experiments in America, were never able to obtain a similar result with less than 16 cubic centimeters of milk. In 1920 Hopkins (3) repeated his work and confirmed his original result. There are those who thought that the explanation lay in the fact that Hopkins is a wizard in the handling of animals; but if so, there must be at least two wizards in England, for Hopkins's work has been confirmed in Lever's laboratory (4) in the course of experiments which were designed for other purposes. It has always seemed to me that behind this bit of work may lie at least a part of the explanation of the position which England holds as a stock-breeding country, and that it would be well worth while to extend the work over a wider field in both England and America. It may be that even when the cows are on summer feed and in a country no larger than England there may prove to be variations in the amounts of accessory food substances in the milk from different parts of the country.

In England our temperature conditions do not run as they do here. They run not as high in the summer as yours do. A temperature of 80° F. is excessive with us, and we really get it only at intervals in the summer time. When you consider your temperature here in New York and compare it with ours in England it makes an enormous difference in the effect of the problem.

Again, England is very small. The other day I went a short distance, from Boston to Washington. I could not have done that in England. That means that our hauling must be shorter than it is in some other countries.

Again we have a great number of people congregated in a small area, and if we had our methods of carriage properly organized we ought to still further reduce the haulage of our milk.

Some years ago, when I first went to Reading we were wondering what we could do for the best manner in helping the great industry with which we were concerned, and we discovered that in England one of the greatest curses was souring. Consequently, we set ourselves down to find what milk in England could do, and for that purpose we carried out a very long series of experiments in which we studied and worked with the keeping and carriage of the best commercial type of milk in England, and to compare this bacteriological stage of the milk with the average milk. The result was a complete revelation to me.

We found two very important things. We found that in England milk properly taken and sent by rail in quart bottles without ice protection, which is not customary, and enduring the temperatures varying as much as 17° during the year, depending upon the time of the year, and also that milk reaching us 24 hours after it has been taken, still maintained its bacteriological standard. I do not know if this is true abroad and in this country, but it was an undoubted fact with us and an enormous help to us in assisting the farmer and others to produce a better milk in our country.

It must be understood that we are speaking of commercial milk of certified standard, which in England is almost always cooled with water to temperatures which may vary from about 45° F. in the winter to 60° to 62° F. in the summer. Such milk, if it be contained in properly washed and steamed vessels, can travel for 24 hours with little addition to its bacteriological content, provided that its temperature does not exceed 60° F. on arrival at its destination. It must be remembered that in the course of its journey the milk has endured whatever variation of temperature it may encounter, since it is not customary in England to keep milk cool in transit by any artificial method. This is a very interesting and important practical observation. I show you two tables which demonstrate some of the results which have been obtained. It would be possible to show you many more, but these will suffice to demonstrate my points. (Tables 1 and 2.)

TABLE 1.—*Bacteriological examinations of clean, cooled, bottled milk.*

[Maximum temperature, 62° F.; minimum temperature, 45° F.]

Date.	Age of sample.	Temperature of cooling.	Temperature on arrival.	Number of colonies in 1 cubic centimeter.	Acid and gas in 1 cubic centimeter or less. ¹
1917.	<i>Hours.</i>	<i>° F.</i>	<i>° F.</i>		
Oct. 25	23	52	54	570	—
Nov. 1	22	55	58	2,300	—
Nov. 15	23	52	51	3,000	—
Nov. 22	23	52	57	3,100	—
Nov. 29	22	51	62	500	—
Dec. 6	22	50	43	400	—
Dec. 13	22	50	50	150	—
Dec. 20	22	46	37	170	—
Dec. 27	22	.....	49	240	—
1918.					
Jan. 3	22	46	50	4,000	—
Jan. 10	22	51	49	1,200	—
Jan. 17	22	45	44	400	—
Jan. 24	23	50	56	300	—
Jan. 31	22	.....	45	350	—
Feb. 7	23	50	55	800	—
Feb. 14	22	50	48	800	—
Feb. 21	22	.....	46	200	—
Feb. 28	22	48	49	460	—
Mar. 7	22	49	46	600	—
Mar. 14	23	50	51	600	—
Mar. 21	22	51	52	110	—
Mar. 28	22	50	50	250	—
Apr. 4	22	50	51	40	—
Apr. 11	22	54	50	10	—
Apr. 18	21	50	44	Nil	—
Apr. 25	22	51	55	500	—
May 2	22	52	50	400	—
May 9	22	55	56	240	—
May 16	22	54	63	300	—
May 23	22	62	60	500	—
May 30	22	57	66	300	—

¹ Acid and gas indicate the presence of lactose-fermenting organisms.

Table extracted from Journal of Hygiene, vol. 21, No. 2, December, 1922.

TABLE 2.—*Number of samples of clean, cooled, bottled milk developing various numbers of bacterial colonies at different temperatures.*

Number of colonies per 1 cubic centimeter.	Temperature on arrival at laboratory, 41° to 50° F.	Temperature on arrival at laboratory, 51° to 60° F.
0- 1,000	6	6
1,000- 5,000	4	6
5,000- 10,000	.....	.....
10,000- 30,000	.....	2
30,000-100,000	.....	.....
100,000-200,000	.....	.....
Over 200,000	.....	1
0- 1,000	8	13
1,000- 5,000	.....	6
5,000- 10,000	1	1
10,000- 30,000	.....	1
30,000-100,000	.....	.....
100,000-200,000	.....	.....
Over 200,000	.....	.....

Table extracted from Journal of Hygiene, vol. 21, No. 2, December, 1922.

Whether it is that this condition is due to the fact that the bacteria present in the milk, most of which must have come from the udder, have been enfeebled by their stay there, or whether they have no

natural affinity for milk, or whether the bacteriolytic power of fresh milk is greater than had been supposed, we do not know. There is evidence in favor of the last view, since we are finding that the addition of starter to fresh clean milk involves adding it at least 24 hours before an increased acidity is wanted since it takes 24 hours for this increase to take place. This has sometimes led to amusing and agitated telegrams from dairymaids on certified farms where a surplus has occurred, making it necessary to convert some of the milk into cheese.

Whatever the cause may be, there is no doubt about the fact, and it has proved of the greatest value to us in the conduct of some of our work. It would be interesting to know whether or not this fact is equally true of the milk of other countries. So far as we can gather, it does not appear to be so.

For us, however, it is of great moment since it is associated with a further fact, namely, that milk of this character remains sweet for a period of not less than two days from the time of milking.

Here, then, lies a simple solution of the raw-milk problem as it exists in England, namely, that we shall deliver our milk to the consumer within 24 hours of milking. If we do this and keep our milk at or below 60° F. during its journey from the farm to the dealer's premises, a once-a-day delivery will suffice, since the figures in Table 3 show that such milk can be guaranteed to maintain its sweetness in the house for a minimum time of 24 hours.

TABLE 3.—*Keeping qualities of grade A (certified) milk at room temperatures in laboratory, and in a cool cellar. Number of samples remaining sweet for length of time indicated.*¹

How long sweet, from time of milking.	Temperature on arrival at the laboratory.							
	41° to 50° F.		51° to 60° F.		61° to 70° F.		Over 70° F.	
	Lab- oratory.	Cellar.	Lab- oratory.	Cellar.	Lab- oratory.	Cellar.	Lab- oratory.	Cellar.
Farm 1, July 14, 1921, to Jan. 5, 1922:								
1 day.....								
1½ days.....								
2 days.....					2		3	2
2½ days.....					2		6	2
3 days.....	1		1		6	5	1	5
More than 3 days.....	3	4	8	9	4	9		1
Farm 3, July 14, 1921, to Dec. 29, 1921: ²								
1 day.....								
1½ days.....					11	2	5	1
2 days.....			1		8	4	4	4
2½ days.....			4	2	22	11	1	3
3 days.....	4		6	2	8	17		2
More than 3 days.....	4	8	8	14	3	17		
Farms 1 and 3 combined:								
1 day.....								
1½ days.....					11	2	5	1
2 days.....			1		10	4	7	6
2½ days.....			4	2	24	11	7	5
3 days.....	5		7	2	14	22	1	7
More than 3 days.....	7	12	16	23	7	26		1

¹ Two days' sweetness indicates that the sample was not tainted at the end of two days, but was sour when tasted at two and a half days.

² Two samples from farm 3 were not examined in the cellar.

Table extracted from Journal of Hygiene, vol. 21, No. 2, Dec. 7, 1922.

At the moment, we have not yet attained to this level in England; for, until quite recently no general effort has been made to

improve the cleanliness of our milk supply; but we are getting there, as the following figures of grade A milk from tuberculin tested cows which is being sold by five different distributors in the town of Reading show. This milk is delivered to the dealer in sealed churns and bottled by him.

You will notice the variations of the temperatures of the milk during the different months. This is one of the problems which awaits satisfactory solution. In Reading we are at present getting over the difficulty by giving the consumer a twice-a-day delivery during the summer, for we have found that even in the hottest weather we can rely upon the sweetness of the milk for at least a day and a half from the time of milking. (See Table 4.) The second great problem is that of satisfactory transport, that it may be made possible for the dealer to get his milk within a fixed period from the time of milking. These ought not to be insoluble problems with us.

TABLE 4.—Condition, when delivered to consumer, of grade A milk sent in cans by rail to retailer.

Date of examination.	Minimum age.	Temperature of milk when tested.	Number of colonies per 1 cubic centimeter.	Presence or absence of lactose-fermenting organisms in 1 cubic centimeter
1922.	Hours.	° F.		
May 26	20	61	11,800	—
June 2	20	72	68,000	—
June 10	21	65	13,500	—
June 16	21	62	8,700	—
June 23	29	62	15,800	—
June 30	29	58	18,400	—
Aug. 11	25	65	2,360	—
Aug. 18	26	64	230	—
Aug. 25	21	63	1,070	—
Sept. 1	21	55	6,400	—
Sept. 8	20	60	1,700	—
Oct. 20	20	52	19,600	+
Oct. 28	20	46	14,100	—
Nov. 11	22	55	3,800	—
Nov. 18	20	49	16,400	—
Nov. 24	21	49	8,100	—
Dec. 2	20	50	7,500	—
Dec. 15	20	50	6,200	—
Dec. 22	24	49	2,900	+
1923.				
Jan. 6	30	51	4,900	—
Jan. 12	28½	46	4,200	—
Jan. 19	28	47	16,600	—
Jan. 26	28	52	10,400	—
Feb. 2	28	52	30,400	—
Feb. 9	28	48	10,200	—
Feb. 16	28	47	17,300	—
Feb. 23	28	46	15,800	—
Mar. 2	28	48	10,600	—
Mar. 9	28	48	55,000	—
Mar. 16	28	50	3,400	—
Mar. 23	28	50	61,000	—
Mar. 30	28	47	11,200	—
1923.				
Jan. 12	28	44	6,200	—
Jan. 19	28	47	28,100	—
Jan. 26	28	46	6,000	—
Feb. 2	28	52	10,800	—
Feb. 9	28	48	83,000	+
Feb. 16	28	48	14,300	—
Feb. 23	28	46	13,200	—
Mar. 2	28	48	7,800	—
Mar. 9	28	48	17,800	—
Mar. 16	28	49	116,000	+
Mar. 23	28	50	8,400	+
Mar. 30	28	47	105,000	—

In connection with variations in temperature, I have been much interested in reading American literature which tells of the value of insulated cans in keeping milk at a constant temperature. It may be that if we find a satisfactory method of cooling at the farm at all seasons of the year, such cans may prove to be a valuable asset to us. In connection with the latter, it must be remembered that our maximum haulage is not more than 200 miles and, indeed, should as a rule be much less. This is evident if one considers how closely congregated together are our great centers of population and how small relatively is the total area of our country. In America, on the other hand, I am told that milk must be hauled over distances varying from 50 to 500 miles. In England we do not get either the excessive heat or the excessive cold with which you must contend. I gather that your temperatures may vary from -30° to over 100° F. In the last seven years, it has been the rarest possible thing for us to receive milk at 32° F. and a temperature of 100° F. is unknown, the highest records we have ever had being 88° F. The problems of milk distribution in the two countries, therefore, differ very materially and can only be satisfactorily solved by a careful study of the conditions in each country.

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Chairman WILLS. We shall not ask for discussion at this time, but shall expedite matters for our next speaker. The next speaker is Dr. J. S. Latham, of the United Dairies, Ltd., England, and his subject is "Milk transport in England." Doctor Latham is unable to be present, and Mr. Lane, of the United Dairies, will read the paper in his absence.

Mr. LANE (United Dairies, Ltd., England). The subject of Mr. Latham's paper is "Milk transport in England," as managed by the United Dairies. As you will note by the program, Mr. Latham is on the board of directors of the dairy.

I should like to say that I offer this meeting Mr. Latham's apologies for his absence here to-day. He quite intended to be here to-day, but at the last moment he was prevented from doing so and I was asked to look out for the reading of his paper. I am sure he will very much regret he has not come to the United States, and he has not had the opportunity of being entertained in such a hospitable way as every Englishman has.

I have to say, gentlemen, that my eyes are not very good for reading this paper. It so happens that my son has been studying in America for the past eight months. He is here this morning and will read the paper in my stead. [Applause.].

(Mr. Lane, jr., read Mr. J. S. Latham's prepared paper.)

MILK TRANSPORT IN ENGLAND.

JOHN STANLEY LATHAM, chairman of the transport committee, and director, United Dairies, Ltd., London.

The part all forms of transport play in the life and progress of a country and the enormous effect it has on the country's development are of great importance, for countries with few railways and poor roads stagnate, whereas the hall mark of the dominant countries of the world is efficient railways, good roads, and other specialized forms of transport.

The carrying of goods by road has, since the war, received great attention, and its development into a business factor is one of the outstanding features of the transport world. Special vehicles for particular products, separate controlling departments for the handling of road traffic and vehicle maintenance, and the creation by the State of a roads department are indications of the trend of events, from which may be deduced the fact that the ease, convenience, and reduction of handling involved when products can be collected or delivered with one loading, are making themselves felt as a potent factor in the commercial life of Great Britain.

In no business does transport play a greater part than in the milk trade, since from the moment the milk is taken from the producer its successful handling in every stage until its delivery to the consumer depends on efficient and prompt transport. In the last few years large economies have been effected at the farming and the distributing ends; in the former by the motor vehicle collecting the milk from farm to farm instead of each individual farmer sending it to the creamery by his own cart; and, in the latter, so far as London is concerned, by the amalgamation of many firms, thus avoiding overlapping in delivery.

United Dairies, Ltd., the largest firm of its kind in Great Britain, handles over 1,000,000,000 pounds per annum, employs over 10,000 people, requires the use of special railway trains with special facilities, a fleet of over 400 road vehicles, of which 300 are motor vehicles, 1,000 horses, and 100 factories and receiving depots.

In such an organization transport plays a most important part, for without it such a perishable commodity as milk could not be transported without delay from the far distant country farms to the hundreds of thousands of consumers in great cities. Nature's greatest food could never reach hospitals, public institutions, and the general public in its fresh state.

RAILWAY TRANSPORT.

The part played by the British railway companies is that of providing the necessary accommodation for loading at the country stations, and in most cases special trains for conveying the milk, and, so far as London is concerned, to run these into the principal termini, where separate platforms and separate stations—the former of the same height as the motor and horse wagons—are in use. It is a point of interest that the London supplies are in the majority of

cases obtained from depots over 75 miles away. On the score of economy, special efforts are made to purchase milk on those lines of railway the termini of which are nearest to the particular town depot for which it is destined.

ROAD TRANSPORT.

The activities of the United Dairies road transport can be considered under three headings, starting with the producer and finishing at the door of the consumer. They are:

1. Collection from producer to country depot, where it is chilled or Pasteurized, and thence to country railway stations for transit to destination.

2. Collection from town railway termini and delivery to Pasteurizing plants.

3. Delivery: (a) Wholesale, (b) retail.

1. *Transport from country to town depot.*—The collection on seven days a week of milk from many thousands of farmers, spread over an area of approximately 30,000 square miles, by nearly two hundred 3-ton and 30-hundredweight motor lorries, from about 60 receiving depots, is a considerable problem, requiring a system in which nothing can be left to chance, as the reserve carrying capacity never exceeds 5 per cent; therefore these lorries, running over all classes of roads and traveling 2,000,000 miles per annum (which is equivalent to 80 times round the world), demand unremitting care both in operation and maintenance.

Owing to the considerable fluctuation in the quantities to be collected, great care is taken to obtain full loads for each vehicle throughout the winter and summer—in the former period by reducing the number of lorries in use, and in the latter by increasing the carrying capacity of the 3-tonners by 1 ton. This is effected by utilizing an additional platform situated immediately behind the driver's cab, at a sufficient height to clear the churns on the main platform. Assuming that 600 gallons is the normal load for a 3-tonner, this arrangement allows an additional 200 gallons to be carried per vehicle per journey which, applied to 130 such lorries, gives an increased carrying capacity of 260,000 pounds daily.

Each depot has sufficient motor transport to deal with the amount of milk likely to be collected, in addition to meeting with many other requirements. It is essential that for every churn collected an empty one be left; therefore each morning the lorries proceed on their daily journeys loaded with clean empty churns, and return with full ones to the depots, where the milk is dealt with prior to being transported to its destination by road, rail, or a combination of both. In addition to milk collection, thousands of tons of products manufactured or dealt with by the United Dairies (Ltd.) are handled.

All the milk handled by United Dairies (Ltd.) in London arrives by rail.

2. *London end.*—The collection of about 2,000,000 pounds daily from the various London termini, and its delivery to United Dairies

Pasteurizing plants and town distributing centers involves the employment of over 100 petrol and electric vehicles, varying in capacity from 1 to 4 tons, and a very large number of horse-drawn vehicles. Owing to the fact that the greater part of milk arrives at night, it follows that many of the motor vehicles do a considerable amount of work during this period; but to increase their usefulness in certain cases two drivers are used, whereby the vehicles can be employed practically without interruption over the full day. It is interesting to note that under the above conditions there is scarcely any difference in the cost per gallon for handling, between petrol, electric, and horse-drawn vehicles.

3. *Delivery*.—The huge quantity of milk has, after treatment at our Pasteurizing and cooling depots, to be distributed to over 600 United Dairies shops, thousands of dairymen, a great many hospitals and public institutions, and hundreds of thousands of private consumers, necessitating an immense delivery organization. The activities can be considered under the headings: (a) Wholesale, (b) retail.

(a) In this connection the milk is taken direct from the trains to United Dairies Pasteurizing plants specially provided for dealing with it, after which it is delivered to proprietary dairymen and large consumers. This service calls principally for the employment of a considerable number of heavy-type mechanically propelled as well as horse-drawn conveyances.

(b) An important part of the activities of the United Dairies (Ltd.) is the distribution of new milk and other dairy products to the public, which service, taking into account its immensity and the responsibility of handling such a perishable commodity, ranks in importance, as far as London is concerned, with such duties as those of the postman, and in some respects is even more important, since the first meal of the day is dependent on its prompt and early delivery.

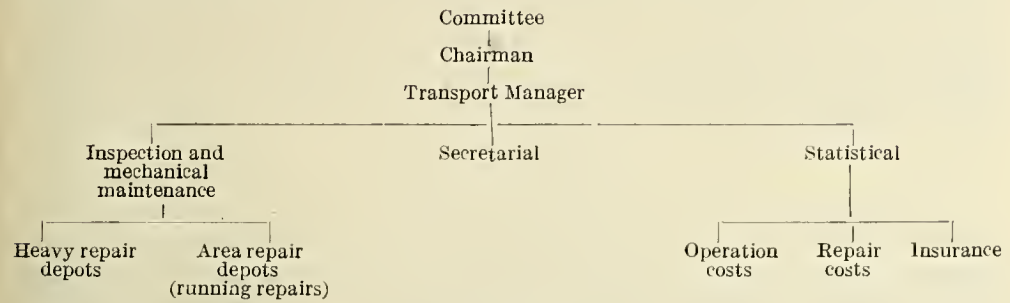
After delivery to retail distributing depots, the milk is prepared for the consumer in sealed bottles or loose in cans. Its delivery involves some 3,000 separate routes, all of which, with the exception of about 600 pony and horse carts and vans, are worked by push trucks.

ADMINISTRATION.

From the foregoing remarks you will have formed some opinion of the immensity of the system under consideration, and will have asked yourself the question: What form of organization is in existence to control and maintain the hundreds of costly mechanically propelled vehicles, and to insure that their operations are carried out in an economical manner?

For the purpose of administering country depots they are put under the control of two directors who have separate areas. These, with a London director, form a committee and are able, through a system of detailed monthly returns, to keep in touch with the operations of every vehicle. Centralization of control, coupled with standardization of type and make of vehicles and decentralization of

repairs, is the adopted policy. The following diagram indicates the channels of control:



INSPECTION.

Great stress is laid on the regular inspection of each vehicle. For this purpose skilled engineers are employed and provided with motor bicycles in order that they may visit any of the depots at which transport is kept. A special form is used which calls for the following information:

Appearance.—(1) General. (2) Engine; running condition; mileometer reading; condition of chains and transmission; condition of brakes; repairs required; action taken; stocks (oil and petrol); are the daily returns up to date?

The last item for use in connection with statistical returns described elsewhere. Thus the transport manager is enabled to keep in frequent touch with the condition of all the vehicles and to issue any necessary instructions.

REPAIRS.

In order to reduce the idle running to a minimum, the repairs are done as far as possible at some depot which is conveniently situated to deal with any number up to 25, which number represents the approximate number of vehicles which three or four milk depots would use for the collection of their milk, etc. Three or four such repair depots are designated to an area, and the person immediately responsible for the vehicles is called an area mechanic, whose duties are as follows:

1. In conjunction with the milk depot managers, to operate the transport as economically as possible, to arrange the routes so as to cut overlapping, to reduce idle running to a minimum, check petrol consumption, etc.

2. To visit each depot in his area every 7 to 10 days for the purpose of carefully inspecting the transport and doing any necessary repairs, which latter function is most necessary, as, in addition to prolonging the life of the motor lorries, the proverbial stitch in time saves delay and money, thus reducing the risk of breakdowns to an almost negligible quantity.

3. To completely overhaul each vehicle in its turn. Such an arrangement as the above does away with the necessity of maintaining one or two large central repair depots, and in so doing reduces the idle running which would take place when lorries were being sent for overhaul. As the milk is collected from an area exceeding half

of England, it is necessary that these area mechanics be stationed at suitable centers for their work. In London the reverse system is in operation, one large central depot being provided. Each country vehicle is thoroughly reconditioned after it has completed approximately 25,000 miles, at a cost, including running repairs and solid tires, of about £10 per 1,000 miles run. The repair and tire bill exceeds £20,000 per annum.

STATISTICAL.

An important factor in connection with the United Dairies organization for the control of their transport is the preparation of accurate statistics, as economy in operation and maintenance can not be truly exercised without correct figures, tabulated and presented in such a manner as to show at a glance the weak spot in connection with any particular depot or vehicle. In order that the costs of collecting the milk and the various commodities carried by the lorries may be ascertained, a system of returns utilizing three correlated forms has been adopted, from which a detailed report is obtained for consideration by the transport committee monthly.

The first form is issued in pads of 25 to the drivers, who are required to fill it in daily and present it to the depot office. It calls for the following information:

1. Name and date.
2. Registered number and make of vehicle.
3. Mileometer reading at start and finish of day's work.
4. Milk collection (from farm): Miles-----; gallons-----
5. Milk collection (central stands): Miles-----; gallons-----
6. Whey, separated milk, cream: Miles-----; gallons-----
7. Milk delivered to station or other depot: Miles-----; gallons-----
8. Empties at station or other depot: Miles-----; gallons-----
9. Cattle foods: Miles-----; weight-----
10. Miscellaneous: Miles-----; weight-----
11. Fuel and oil received, and any remarks.

From the above it will be noted that a considerable amount of work is done other than the collection of milk from farms or conveniently placed stands; the latter being places to which milk is brought under contract from very narrow lanes and inconveniently placed farms.

From this form a monthly return is compiled by the depot manager, which is forwarded to the head office of United Dairies (Ltd.) on the 2d day of each month. This return is the connecting link between the work done by the lorries and the chief office, and is most important, because unless it is correctly filled in, all the other figures evolved from it will be incorrect. An interesting and very comprehensive set of figures is obtained from this form, whereby it is possible to analyze the following:

- The operations of each vehicle.
- The cost of collection per gallon.
- The cost per mile for running.
- The gallons collected per mile run.
- The total costs of the individual operations as stated above in items 4 to 10, and cost of maintenance.

The "gallons collected per mile run" is a splendid index as to whether a vehicle is being operated economically, on any particular collection route. The standard for comparison is that at least 170 pounds should be picked up per mile.

For the month of February the country vehicles traveled 140,000 miles and collected 12,900,000 pounds of milk at an average cost of 0.9 penny per 10 pounds. In London 80,000 miles were traveled and over 30,000,000 pounds of milk dealt with at a cost of under 0.3 penny per 10 pounds.

The approximate cost of maintaining and operating the motor lorries, cycles, cars, and horses, the property of United Dairies (Ltd.), annually is £275,000, including the standing charges of depreciation, interest, licenses, and insurance.

FARM INSPECTION.

An important function in which transport plays its part is that of farm inspection. A number of inspectors are employed whose duties consist principally in periodically visiting every farmer who is a sender, for the purpose of inspecting the conditions under which cows are kept and the milk handled, and also to take samples. Such work demands a lot of traveling, particularly along rough lanes and indifferent farm approaches, for which the inspector is provided with a motor bicycle and side-car attachment, fitted with a box suitable for carrying the samples of milk taken for analysis.

This work goes on all the year round, and is, owing to the nature of the roads traversed, fairly hard on the machines. About forty 4½-horsepower machines are in use, their average cost being 2.5 pence per mile.

TRANSPORT OF ADMINISTRATORS.

The administration of an area greater than half of England, from which supplies are drawn, requires the employment of a number of responsible and experienced persons who, if their duties are to be carried out expeditiously, must be provided with some sort of transport. United Dairies (Ltd.) have about 35 cars in this service, principally of the 10-horsepower 2-seater class.

An item of interest is that for country work only two types and makes of lorries are in use; a heavy one of $\frac{3}{4}$ -ton capacity, and the other a light 30-hundredweight. The possession of only two makes is a great convenience, both from the point of view of maintenance and from that of supply of spare parts.

It will be seen that road transport has a large future in which United Dairies (Ltd.), in common with other progressive activities, take a practical interest, and are ever on the lookout for any method of improvement, such as greater capacity wagons, which might increase the rapid handling of their perishable products.

Chairman WILLS. If it is agreeable to the session, we will group our discussion at the end of the papers on the subject of transportation.

Our next speaker is Mr. J. P. Dugan, general baggage and milk agent, Baltimore & Ohio Railroad, and the subject is "Transportation of milk in bulk." Mr. Dugan. [Applause.]

TRANSPORTATION OF MILK IN BULK.

JOHN P. DUGAN, general baggage and milk agent, Baltimore & Ohio Railroad, Baltimore, Md.

Mr. Chairman, ladies, and gentlemen of the World's Dairy Congress, and associates interested in this world-wide industry: When I was asked by your program committee to submit a paper concerning the transportation of milk and cream in bulk, I was only persuaded to attempt it from a sense of duty. We of the railroad are vitally interested in and benefited by the growth and success of the dairy industry. But our point of view differs, in a way, from that of the larger representation here which is interested primarily in milk production, marketing, education, and promotion. We of the railroads see the transportation rather than the making and selling aspect, and it is as a railroad man I offer my observations and suggestions.

When we stop to think that the original door-to-door, pail-and-dipper method, and certainly the spigot-drawn measure of the churn delivery wagon, are still within the recollection of the present generation, the immense progress which has been made in the industry is amazing. When comparison is made of the wagon and stable affair of a few years ago to an institution commanding not only the respect and confidence of the community, but rightly ranking with the foremost enterprises of the world, one sees a marvelous achievement. It was only by perseverance and untiring efforts that this was accomplished, and only those who are familiar with the old-type dairy can appreciate the progressive organization which has replaced it.

However, there are two phases of the milk industry which vitally concern the whole, but which have either remained where they have been since the beginning, or certainly have not kept pace with the other developments. I question if the importance of supply handling is as fully appreciated as it should be and if there is not room in this direction for a great deal more economy and improvement in quality than is generally supposed.

I speak, first, of the container or can system of shipment compared with the modern tank or container car method of handling in bulk; and, secondly, of the consolidated source of development of supply so closely related with the tank shipment method.

HOW RAIL TRANSPORTATION OF MILK DEVELOPED.

The transportation of milk by railroads became a necessity when the city population began to outgrow the supply of the dairies which were located within city limits or driving distance, and which kept herds fed on brewery and distillery refuse. According to historical data collected by the Milk Reporter, the first shipment ever made on a railroad train was over the old Boston & Worcester Railroad into Boston in April, 1838, or 85 years ago. The result of this experiment is not known, as there is no further record of it, and apparently it was not a commercial success.

The most reliable information available shows that railroad shipments were successfully started in 1841 from Orange County, N. Y., into New York City, and while this venture was at first ridiculed

and looked upon with suspicion, the perseverance and confidence of the shipper finally demonstrated its practicability.

Ever since the success of train shipping was established, the can container has been commonly and generally used, and is still depended upon in moving the bulk of the country's milk supply. The country's annual milk crop for home consumption or city dairy purpose, as near as we can approximate it, is now 46,672,600,000 pounds, or 5,490,894,117 gallons, and the increasing expense of cans on the business is apparent.

This indicates a daily average supply of about 15,043,546 gallons, most of which is shipped in 5, 8, and 10 gallon size cans. To ship it in 10-gallon cans would require 1,504,355 cans, but as it takes three sets of cans to protect one shipment, it is fair to assume that at least 4,513,065 cans are in use in handling one daily supply of milk. A fair average price for a can is \$4, indicating an investment of \$18,052,260 for cans alone.

I often wondered, in my contact with the service, why some other more economical and sanitary arrangement was not possible. It did not seem right or in keeping with the progress of the industry generally, that a shipping arrangement born with the business should stand still. Hence, I could readily appreciate the possibilities of tank cars when they were first proposed to me by the Harmony Creamery Co., although on first impression it looked like a radical departure indeed. The difference between a 10-gallon can and an immense vessel holding thousands of gallons without refrigeration protection was startling. As the pioneers years ago proved the practicability of shipping milk by train, so it has taken pioneers to prove the practicability of the tank car.

When Sunday shipments of milk were first proposed it was not customary to operate trains on Sunday, and the necessity of doing this, as agitated by dairymen, met with determined opposition. Meetings were held and protests made against the innovation, the difference in opinion disrupting communities, and the subject remaining in heated discussion until a Sunday milk train was run. When this was done, the railroad and the sinful dairymen were earnestly denounced, one minister even declaring that the curse of God would surely be visited on those responsible for it. The dairy industry can in a large measure take the credit for providing the necessity for having a Sunday train service.

I do not mean to say that the tank car has met with the ridicule which the old pioneer dairymen did, or has been opposed as an unrighteous innovation. Civilization has moved fast since that period, and many inventions not dreamed of then are now in successful operation, but it has taken the same confidence and leadership to demonstrate the practicability and value of tank cars as it took in those early days of dairying, and those who were first to introduce them will, in my opinion, eventually be honored with the credit of giving the industry an invention of distinct economic advantage.

TANK CAR HAS PROVED ITS WORTH.

The experimental stage of the tank car is past and it is now recognized as the modern method. Economic and sanitary questions press hard in the milk industry, and it is urgently necessary for those in

the business to try to solve these and related problems. The tank car and consolidated shipments in bulk point the way to their solution.

Perhaps no other industry, excepting the railroad industry, is so surrounded with regulations and restrictions as is the milk industry, and whose scope of management is so limited. Also, its margin between production and selling costs is extremely narrow. There is no other commodity of commerce which is as perishable and sensitive to market, or whose raw state, as nature produces it, must be so closely maintained. It is the recognized world-wide food, the one indispensable to the life of nations.

In my opinion the salvation of the dairy industry for both producer and dealer depends upon reorganizing on a consolidated source of supply basis, on concentrating the operation so that both quality and economy can best be regulated. The tank or container car will help solve this problem, as is emphasized by the enthusiastic satisfaction of the tank-car dairymen to whom it has proved its value. In every instance where it has been tried it has not only more than paid for itself in savings, but also has produced a considerable increase in business. I predict that in every city where it is once started it will force all milk dealers to use it on account of its competitive advantages. I recommend it, unreservedly, to the progressive dairymen.

The economy effected by tank-car handling in bulk depends, of course, upon the size and method of the operation of the dairy adopting it. Operating conditions differ in various communities, so that what can be saved depends entirely upon the local situation. But the saving as a whole is substantial, no matter how well or with what efficiency a dairy is managed. It would not be difficult to give a concrete exhibit, but each dairy has its own problems, and the usefulness of the tank car can best be shown by an actual survey in each case. The following principles, however, will give a mental measure of its advantages to those dairies which are looking forward to their future requirements and are now protected with carload movements of supply:

SAVING EFFECTED AND EFFICIENCY OBTAINED BY TANK-CAR OPERATION.

1. A more uniform or regulated temperature.
2. Improved bacterial or acidity state.
3. Improved efficiency at shipping and city plants on account of reduction in force.
4. Elimination of sour milk losses, etc.
5. Reduction in labor at both shipping and city plants.
6. Discontinuance of refrigeration or icing cars.
7. Elimination in shrinkage or spillage loss.
8. Elimination of shipping cans.
9. Elimination of can washing and similar expense.
10. Elimination of cost of can repairs, replacement, etc.
11. Reduction in drayage or hauling expense at shipping and city plants.
12. Preventing congestion at shipping and city plants.

SCIENTIFIC ASPECT OF THE INDUSTRY.

The railroad man can best confine himself to the transportation phase of the milk problem, leaving the scientific aspect to those better qualified to describe it. But a comparison between the can-container system of handling and the tank-car system, with its absolutely sanitary and air-tight protection, is so apparent that a school child can readily understand it. The bacterial or acidity state is what determines both the quality and life of milk, and the superiority of the tank-car product in controlling these factors is so impressive that it is bound to reflect both its commercial and health advantages. This has been proved wherever the sanitary aspect of milk handling has been stressed, and it has shown a reduction in mortality.

The ratio between the contamination in tank car and can is as 34 is to 1 in favor of the tank car. This is further demonstrated by the acidity or bacterial tests, which in tank cars ranges from 0.14 to 0.15, and in cans from 0.17 to 0.20. As the bacteria or acidity can not be reduced, but can only be controlled, the importance of the regulations covering them, to both the dealers and customers, can not be overestimated. The keeping qualities of the tank-car product are greater than those of the can shipment, no matter how well the can contents are iced and handled, and the tank-car milk will reach the consumer in better condition. As the public is now being educated to understand the value of sanitary protection in dairying, it is no wonder the quality of the tank-car article is immediately recognized and demanded wherever this service has been inaugurated.

The tank car provides as nearly perfect sanitary protection to the milk as can be humanly conceived, being absolutely free from atmospheric, human, or other contact of an injurious character. Its scientific handling from time of delivery by the producer at the country plant until bottled or delivered to the trade, prevents the outside contamination which the can process can not escape.

When recently visiting a plant using tank cars, I noticed in the car vestibule some cans in which sweet cream had been shipped. The tanks had just been cleaned and flushed and the can sterilized. On examining the cans, a most disagreeable odor was plainly evident, while the sense of smell was unable to detect in the tank car the slightest scent other than the sweetness of a milk dew. When we consider the perfect smoothness of a glass-enameled surface of the tank in contrast with the dents, crevices, or seam depressions which every can has to a greater or less extent, the superiority of the tank car can not be questioned.

IMPORTANCE OF TEMPERATURE UNIFORMITY AND REGULATION.

The uniformity and regularity of temperature control, while important in almost all food preservation, is vitally necessary with milk on account of its perishable and sensitive nature. The best that refrigerator or iced cars can do in no sense equals tank-car temperature regularity. In a distance of over 100 miles throughout summer weather, tank-car operation has averaged an increase of only 2° in an eight-hour movement. A difference of even a few degrees is of great value for many reasons, and as it is maintained

throughout the operation, from time of cooling at shipping plant until bottled for the customer, the advantages it reflects in preserving the product are bound to assert themselves in the quality.

The noiselessness and smoothness with which the tank-car operation is handled at the city dairy, compared with the pressure and congestion which can hauling and dumping necessitate, while not a monetary value, give a commercial appearance of plant efficiency which is an asset to the business. Mechanical or pipe loading from shipping plant to car and unloading from car to city dairy in bulk not only permits it to be managed and regulated with dispatch, but confines the operation to a time limit which is impossible with cans.

SOURCE OF SUPPLY AND CONSOLIDATING SHIPMENTS IN BULK.

It is of course understood that tank-car operation is only feasible with shipments in bulk.

Most of the prominent dairies have long ago recognized advantages of bulk supply or carload shipments, and the country shipping station has been in existence ever since it was originated, in 1885, by Mr. Robert E. Wescott, the former president of the Wescott Express, who inaugurated this system of shipping along the Delaware, Lackawanna & Western Railroad (thereby, no doubt, creating an express interest). Even so, there are still many dairies who are still dealing with the direct shipper or whose supply is divided in many directions.

I have always felt, and those dairy friends of mine who ship over the Baltimore & Ohio confirm, that the success of the dairy largely depends upon the concentration of supply source in one or as few locations as possible, instead of dividing it. I have noticed that wherever this has been done, it has not only been successful but that these dealers are better protected with supply. It not only consolidates their management with less operating expense, but also allows better regulation of quality and supervision. It is certainly better to have one community to deal with in promotion and development work instead of many.

The advantages of this concentration of supply in flush or short-age periods are many, and as far as volume is concerned, wherever dairying is a fixed industry, the supply of milk can be developed to a surprising quantity. The dealer only has to choose the most adaptable location for his shipping station and wait a reasonable time to build it up. I have in mind a number of places where our dealers have done it, and where supply has developed from a few hundred gallons into thousands. The industry will grow fast in a community as the producers are taught to appreciate its value, and it can be gradually extended back with subsidiary collecting stations to feed the main plant. Another patron of ours has but recently decided to adopt this plan, even at a considerable expense to bring about the organization. The great saving it will bring him will pay for the investment within three years.

With the limit of production constantly increasing, the supply demand along the Atlantic seaboard must either be increased by more intensified dairying or brought in from a much farther distance. The dealer who consolidates his activities into more intensified development will not only better protect his supply, but accom-

plish economy which is not possible otherwise. In the matter of transportation rates, refrigeration, plant operation, management, etc., it is certainly the coming thing to do.

The consolidation of plant performance and management under one head, with only a collecting station operation as subsidiaries feeding the main factory becomes necessary, is eliminating expense instead of increasing it where supply is scattered.

I earnestly recommend as a thought of constructive benefit, if not the salvation of many dairies which are now confronted with a supply and expense problem, the concentration of supply along these lines, even aside from tank-car advantages. Where supplemented with the tank car's greater efficiency and economy, I predict an even more successful future for the dairy taking advantage of them.

Chairman WILLS. Our next speaker has the subject, "Bulk transportation of milk by rail." Mr. H. E. Black, superintendent of milk service, New York Central Railroad. [Applause.]

BULK TRANSPORTATION OF MILK BY RAIL.

H. E. BLACK, superintendent of milk service, New York Central Railroad.
New York City.

Inasmuch as my duties connect me chiefly with the transportation of milk into the New York market, my remarks will for the most part pertain thereto. This is both fitting and proper because we here find not only the most severe obstacles to transportation, as long haul, strict regulation, expensive terminal facilities, and labor, but maximum traffic and the ultimate product reputed excelled nowhere in the world.

When it is now considered that the bulk of the milk for New York City consumption is transported from distances in excess of 200 miles, and that this distance is constantly being increased in order to meet the demand for the product, the necessity for combined and intelligent effort by the producer, the distributor, and the consumer, as well as the carrier, to solve the problems incident to this long haul, will be readily appreciated.

GROWTH OF MILK TRAFFIC INTO THE NEW YORK MARKET.

Let us consider now the size and growth of this traffic into the New York milk market, and let me here qualify the market as a zone of 20-mile radius described about Manhattan Island as a center.

In the year 1922 there were 26,797,744 40-quart cans of milk and 1,637,164 40-quart cans of cream and condensed milk handled in the market, which represents an increase over the traffic of 1885 of 444 per cent in the case of milk and 851 per cent for cream and condensed milk.

Consideration of these figures should cause some speculation as to where the New York market will obtain its supply 25 years hence. Educational campaigns and the wonderful growth of the ice-cream industry, together with the normal growth in population, have brought about the present volume of traffic, which if we are to cope

with it in the future means that two factors must be taken into consideration:

First. There must come more intensive dairying, in the form of higher average production per cow.

Second. The possibilities of going farther afield for milk must be developed. This is largely a transportation problem.

UNDESIRABILITY OF CAN.

As you are undoubtedly aware, the greater part of the traffic into New York City is handled in the standard 40-quart can, only about 18 per cent being handled in bottles by the transportation companies. For many years the can has been recognized as undesirable for a great number of reasons, for the handling of milk, yet it has continued in use. Let us trace one cycle in the life of a can and see its many shortcomings. First, let us consider the initial expenditures and the capital tied up in a property on which the owner has at best a very poor account. We have the statement from one large distributor in the New York market that they own and require for their business 125,000 cans, which at the prevailing cost of \$4 a can represents a capital expenditure of \$500,000, to which it is stated there is an annual replacement of 15,000 cans, or \$60,000. Let us now consider the expensive handling charges and the many possibilities of contamination.

Starting with the rinsing of the can in New York following the removal of contents, we have the first operation; second, the loading of the truck for transportation to the milk platform; third, the unloading of the truck at the milk platform; fourth, the handling into the car from the platform; fifth, the unloading at country plant from the car; sixth, the handling into the washroom from the platform; seventh, the washing and sterilization; eighth, the handling from the washroom to the filling room; ninth, the filling; tenth, the handling to the storage room; eleventh, handling to the platform; twelfth, loading into the car; thirteenth, icing of milk in the car; fourteenth, unloading from the car at destination to the milk platform; fifteenth, loading the truck from milk platform; sixteenth, unloading of truck at plant; seventeenth, removal of contents from cans. Each of the 17 handlings of the can plays its part in shortening its life and takes its toll of the original enormous expenditure.

TANK TRANSPORTATION AND ECONOMIES.

As previously stated, the numerous shortcomings of the can have long been appreciated, but it remained for a progressive milk company of Pittsburgh, Pa., to take the initiative in an attempt to overcome the losses which they were experiencing in cans. Their intelligent thought on the subject led them to the introduction of the tank car for handling milk, and under conditions existing in that company the result was admirable. Their project employed the use of two large glass-lined steel tanks of 2,500 gallons capacity each, placed one in each end of a refrigerator car. Milk is pumped into the tank at the country plant direct from the cooler and pumped out at the railroad terminal to tank trucks for transporta-

tion to the city plant. To demonstrate the economies effected by this project over a period of one year of operation, allow me to quote figures supplied by that company on the basis of the two cars which they now have in operation:

On mechanical loss of product—that is, loss occasioned by spilling while filling cans, milk adhering to the can, cans incompletely emptied, leaking cans and like causes—the saving was \$4,197.18; through economy in ice, as no refrigeration is required in transit, the saving was \$4,171.86; in labor, the services of 14 men being dispensed with, the saving was \$15,550.50; saving in cans, \$2,000; saving in trucking, one 4-ton truck for 20 hours a day being eliminated, \$5,110; on loss due to sour milk, based on amount of previous year, the saving was \$4,236.40; the total annual saving was \$35,265.94.



FIG. 1.—Milk tank being hoisted upon container car.

When first confronted with these figures and an explanation of the project, it was our thought that here at last was the solution of all transportation difficulties pertaining to milk, which would, in addition, be most attractive to shipper and distributor, but the more we gave thought to the matter, the more difficult it seemed to reconcile this project to conditions as they exist in the New York market, until finally we were obliged to admit that it would not meet our requirements. However, it had the desired effect, and had stimulated our interest in the direction of bulk transportation.

MILK-CONTAINER CAR.

It remained for President A. H. Smith, of the New York Central Lines, in conjunction with Mr. E. G. Miner, of the Pfaudler Co., to devise what appears from tests thus far conducted to be the solution of all the foreseen difficulties, and what will open up unprecedented distances for milk and cream transportation, namely, the container-car adaptation for the transportation of milk. This project contemplates the handling of milk, cream, and condensed milk in a portable container consisting of a glass-lined steel tank, which in the case of containers now built has capacity of 825 gallons, encased in an insulated container of extremely rigid construction.

The tank is provided with a 2-inch sanitary outlet valve for discharging contents, located in the side at the bottom, and a manhole for the entrance of a man into the tank for cleaning purposes, located

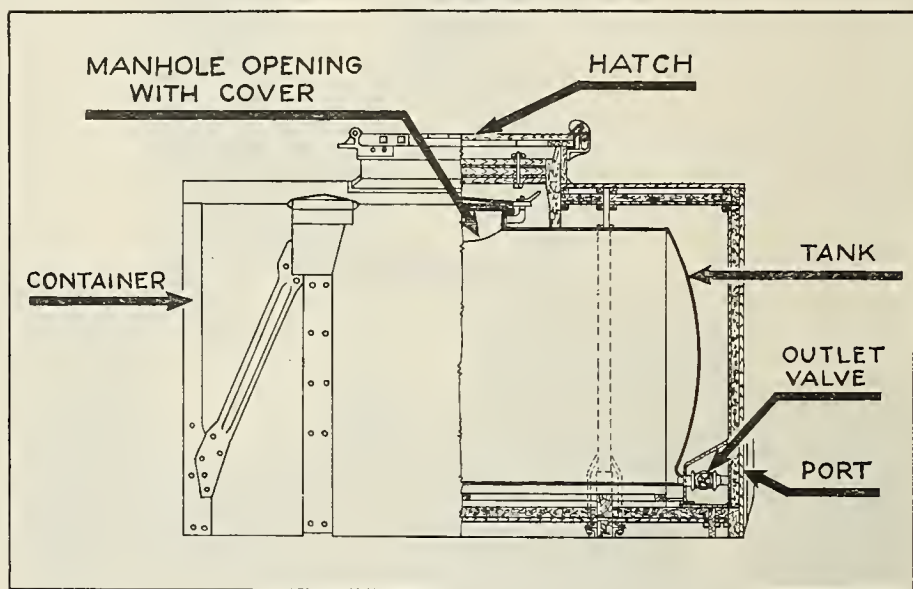


FIG. 2.—Diagram of container-car tank.

in the top of the tank. The manhole is provided with a cover which is hinged and may be tightly secured after cleaning. In this cover are also located the filling fixture, sight glass, and a sanitary air-release valve which is opened in filling to relieve air pressure. Access to filling and discharging valve is gained through hinged doors which are provided with locks to prevent tampering with the contents of the tank while in transit.

The container system provides that the portable container shall be filled and locked at the milk-shipping station and lifted aboard the container car by a simple device, as a hand derrick and tackle attached to the four eyelets, one on each top corner of the container. The car, which permits the loading of multiples of these containers, is very similar in appearance to the low-side gondola, and the steel sides absolutely prevent removal of the contents of the tank through the outlet valve, which is directly against the steel side when the container is in position. At destination the container is lifted by crane from the car to the consignee's truck for transportation to the

distributing plant, where it is emptied by attaching sanitary pump and piping.

No refrigeration in transit is necessary, the precooled condition of the contents of the container being sufficient, in conjunction with the high degree of insulation, to maintain constant temperature. This fact has been thoroughly demonstrated by tests under extreme conditions with actual load of milk; one test being made on February 14 with prevailing atmospheric temperatures ranging from 10° below zero to 10° above zero, under which conditions the temperature of the milk changed only 2°, from 40° to 38°; another, on June 22, with the atmospheric temperature reaching the extreme height of 96°, at 1 p. m., under which conditions the temperature of the milk rose only 2° over a period of 22 hours, from 45° to 47°.

ADVANTAGES OF CONTAINER-CAR METHOD.

The container system for the transportation of milk has many marked advantages over methods previously devised for this service. Let us first consider the numerous advantages over handling in cans, through reduction of the number of operations in the cycle of transportation, with consequent saving of time and labor, as well as permitting of more economic and efficient utilization of plant facilities.

The removal of the contents of the tank may be accomplished direct from the truck, as in the case of tests thus far conducted, but to a large extent this is dependent on conditions at the plant, which readily indicate the most efficient method. Following this we have the first operation in handling the tank, viz, cleaning and sterilization. This requires the services of only one man, who can easily perform the operation in from 10 to 15 minutes. This operation alone will be appreciated as a great economy in the distributing plant, when considered as opposed to the time and labor required for the cleaning of 83 standard 40-quart cans, not to mention the relief from congestion of plant facilities.

The second operation consists of the handling of the container from the truck to the car, requiring only a momentary detention. The third operation is the unloading of the empty container at milk-shipping point. The fourth operation consists of the filling of the tank direct from the cooler, no further cleaning of the tank being necessary if this was properly performed at the distributing plant. The economy of time at this point is particularly marked, as is also the reduction of labor and the possibility for increased plant efficiency.

Fifth, the container is loaded from the platform to the car, and, sixth, from the car at destination to the truck. These two operations result in a great saving of time, the first requiring about four minutes, and the second about one minute and a half, which will result in more expeditious service. This feature further tends to solve one of the most serious of railroad problems for carriers having terminal facilities in New York City, by eliminating the necessity for delivery platforms; these require extensive space, which when possible to obtain is most expensive.

The seventh operation consists of the discharge of contents at the plant, which requires about 10 minutes. Oppose this feature with

the time required to empty a similar number of cans with the resultant loss of product due to incompletely emptied cans and adhesion to the can, and a conception of the cycle of transportation by the container system is complete. There are further points and possibilities of advantage obtained by this method, such as the impossibility of tampering with the contents of the container in transit, and the storage of the product under proper temperature protection at the plant or in long-distance transportation by truck.

To the foregoing advantages must be added that most important feature, improved product. This fact, which has been amply demonstrated by actual test, was not unexpected, with the decreased opportunity for contamination and the practically constant temperatures, yet was very gratifying when observed by actual bacteriological test, and would alone, in our opinion, justify the use of the container system.

The advantage over other methods of bulk transportation give the container system marked distinction. The container tank is devised to carry in bulk an amount best adapted to the majority of milk-shipping stations without the necessity of the centralization of supply with its attendant disadvantages. Furthermore, the container system utilizes any standard platform truck of adequate capacity without modification for the transportation between rail terminal and distributing plant, thus allowing the owner to employ the truck in more than one service.

With this system, which is now passing through the experimental stage, the future of an adequate and unexcelled supply of this vital product to national health seems assured, and with the attendant economies it would seem entirely possible that a direct reflection might be shown in the ultimate cost to the consumer. Inasmuch as this system is not established commercially as yet, we can not furnish at this time actual figures on the economies, but if you will reflect on the enormous savings accomplished in one year's operation under the tank method totaling in excess of \$35,000, though only two tanks were in service, it is obvious that the container can not fail to justify its use in any market. It is our earnest belief that within the next two years great changes will be seen in transportation and distributing of milk and its products, due largely to this development, and that milk and cream will be seen handled in container cars from points as far west as Chicago to the New York market, which is entirely possible, as the elimination of the necessity for icing in transit will permit the handling in high-speed passenger and express trains, insuring delivery within the prescribed time limit for the particular grade of milk or milk product handled.

Chairman WILLS. I believe Mr. Gallagher, of the New York Central Railroad, has a few remarks to add in regard to Mr. Black's paper.

Mr. F. S. GALLAGHER. Mr. Chairman and gentlemen: Mr. Black's and Mr. Dugan's papers have been very interesting, and I think we have all learned something about transportation of milk to the New

York market. Permission to say a few words in addition to what these gentlemen have said will be much appreciated.

The handling and shipping of milk and other liquids, especially where maintaining a predetermined temperature is necessary, is an important factor. Mr. Black has stated that during the coldest weather of last winter and the extreme hot weather of June of this year the difference in temperature of the milk from the time the tank container was filled to the time it was emptied was only 2°. During this test in the winter, milk in the standard 40-quart cans was frozen. It required time and labor, together with the necessary apparatus, to thaw this milk so that it could be emptied from the cans, while in the tank container the milk was in the very best condition; and during the test in June, when the outside temperature was high, the milk was delivered only 2° warmer than when it was put into the tank at the country plant, and this temperature was maintained by the milk itself and not by the use of ice or other artificial means of cooling.

The tank container is nothing more or less than an enlarged thermos bottle, although we do not undertake to form a vacuum, as is done in some of the thermos bottles, because we found it was not necessary to go to that trouble. We simply use well-known engineering principles in insulation.

The two tank containers that are on exhibition in the fair grounds are the first of their kind. They were built to interchange in the cars with the less-than-carload freight shipping containers; and while they represent a marked advance in the method of handling milk and other liquids, they will, like all other schemes and devices that are offered for consideration and use, be improved upon as we gain more experience with this new method of handling milk. For instance, I doubt the correctness of building a wooden container around the tank. We know that the wooden container around the tank has accomplished the results we set out to obtain, but we can not stop with these results. We must anticipate conditions and a required service and develop and improve the device to a point where it will be the most attractive of all schemes of its kind and make the tank containers as flexible in service as possible.

One improvement, which I think is a move that will be approved by everybody, is the making of the tanks in units so that 16 divisions can be placed on one car rather than 8, and instead of delivering a car of containers for the city dairy having a full-load capacity of 6,600 gallons, or equal to 660 of the standard 40-quart cans, we can deliver in the 16 compartments 9,030 gallons, or equal to 903 of the standard 40-quart cans.

Gentlemen, see what this means to the dairy business where time is one of the most important of items in connection with the handling of milk. Here is a car of milk delivered at the city terminal that has 9,030 gallons of milk ready to be delivered to the city dairy and which can be moved from the car to the truck in from 16 to 20 minutes, and at the dairy, with proper facilities installed, this milk need never be exposed because the container can be taken right up to the receiving tank and the necessary sanitary connections applied to the outlet and the milk deposited in a few minutes from each con-

tainer into the receiving tank. These tank containers are constructed so that one, two, three, or four can be placed on one truck, depending on the capacity of the truck and the highway regulations pertaining to wheel load.

In the handling of milk in bulk by the tank-container method, and in order to get the very best results, certain necessary facilities will be required, but I am very happy to say that the facilities are not very expensive. The two main things necessary are a hoist arranged to lift the container from the truck and necessary floor space for the container, adjacent to the receiving tank in the dairy. I think that it would be taking up too much of your valuable time for me to try to explain the advantages any more than to say that there is a labor saving, a time saving, and a material saving that should be apparent. Labor saving, because after the tank is filled and until it is emptied it is handled by mechanical power; time saving, because the car does not have to be unloaded and the trucks do not have to be loaded by hand; and material saving, most important of which would be ice, and milk cans and lids, and all appurtenances pertaining to their supply and maintenance. This would not be required.

Gentlemen, I have not an ax to grind nor a word of criticism to offer in connection with the present method of handling milk and dairy products, which is, from information I can gather, about the same all over the world. The handling of milk in the small can is simply a perpetuation of the way it started from the time the milkman used to drive along the street and ring a bell to let his customers know he was there and to come out and get their milk. The milk can was used then, and in the early days of transporting milk by rail the milk cans were put into a baggage car or on the platform of a baggage car. This service has increased, until now the railroads construct cars for milk only, and they are made of the proper dimensions to carry the largest number of the standard milk cans. What we have done with the tank container is simply to increase the dimensions of the can and to arrange it in such a way that it can be handled, washed, sterilized, and insulated, and loaded and unloaded between the railroad car and the truck with the minimum amount of manual labor and in the minimum amount of time.

I referred to having 16 tank containers on one car, each having a capacity of 535 gallons, or equal to $53\frac{1}{2}$ of the 40-quart cans. When the car arrives at destination, assuming trucks are available, 53 cans of milk can be transferred from the car to the truck in about one minute and a half, or over 100 cans can be placed on the truck in two minutes or two minutes and a half. In the handling of milk this item of time is something that should not be lost sight of, regardless of the other economies and advantages which can be gained by the use of the tank container.

Chairman WILLS. Our next subject is "The transportation of milk by means of tank motor trucks," by C. E. Gray, president and general manager, Golden State Milk Products Co. [Applause.]

Mr. C. E. GRAY. The previous speakers have dealt with the broader aspects of the problem, and I shall endeavor to say something on the narrower phase of the subject, the transportation of milk by means of the motor truck.

THE TRANSPORTATION OF MILK BY MEANS OF TANK MOTOR TRUCKS.

C. E. GRAY, president and general manager, Golden State Milk Products Co.,
San Francisco, Calif.

REQUISITES OF TRANSPORTATION.

It is unnecessary to say that any system of transportation must be such as will not affect unfavorably the quality of the product. It must be dependable as to the time of reaching destination. Having these things, cost, then, becomes the important consideration; in fact, in most cases cost of transportation determines largely whether milk may be removed from the farm as whole milk or whether it must be utilized in some other manner. In the latter case it is usually separated into cream and skim milk, the skim milk being utilized for feeding at the farm. There are very many farms upon which milk is produced, where on account of the location, road conditions, etc., the attempt to remove the milk from the farm as whole milk would be economically unsound.

DEVELOPMENTS IN TRANSPORTATION PROCEDURE.

Transportation being an important factor, it is obvious that deviations from the usual procedure may be worthy of study, especially if they promise to meet the requirements of dependability without injuring the quality of the product, and at the same time may reduce cost.

During the period when the power factory separator was in general use, it was the practice of farmers in many sections to haul their milk to factories or stations where such separators were in operation, in some cases leaving the entire product and in other cases leaving only the cream and carrying the skim milk back to the farms, principally for feeding purposes. In some sections, at least, where the entire milk was utilized at the factories, the farmers have continued delivering milk to them, notwithstanding the introduction of the hand separator. With the development of certain milk-manufacturing processes requiring large volumes of milk for economical operation, it became desirable to collect milk at smaller stations and then convey it to large manufacturing plants. With such procedure the milk would be received from the farmers at the stations, and there weighed, sampled, graded, and, if necessary, cooled, and the entire volume of product placed in large retaining vats. The milk would then be transferred to standard milk containers, usually 40-quart (10-gallon) cans, in which it would be hauled to the manufacturing plant and again transferred to large retaining vats. During the time when horses and wagons were generally used in hauling, there seemed to be little incentive for deviating from this procedure, but with the introduction of the motor truck, especially trucks of large capacity (5 tons or greater) it became apparent that moving the milk in a large container—as a tank—holding a volume equal in weight to the capacity of the truck, should result in considerable saving in both time and labor, and in prevent-

ing waste which usually occurs in transferring milk to and from small containers.

THE INTRODUCTION OF MOTOR TRUCK WITH TANK.

During the early spring of 1914 the use of a tank in connection with a 5-ton motor truck was suggested. By some it was believed that the backward and forward motion of the milk in the tank as the truck moved over changing grades and unevennesses in the road would be very destructive to the mechanism of the truck. By others it was suggested that the movement of the milk would result in a detrimental churning action. As a remedy for both, it was suggested that baffle plates in the tank would probably be necessary. This, however, being very objectionable from the standpoint of cleaning, it was decided to experiment with at least one outfit, using a tank without baffle plates or other internal obstructions. Such an outfit was put in service early in the spring of 1914. This outfit, both truck and tank, has been in continuous service up to this time, and indications are that both may be used for some time yet. The truck on the 1st day of September, 1923, had traveled 89,089 miles. While only part of this truck mileage has been traveled in connection with the tank, the truck having been used in other freight service in a manner which will be described later, it is apparent that the belief that the movement of the milk in the tank would be injurious to the truck mechanism was not well founded. In fact, with the very large use at this time of tanks in connection with motor trucks, some in similar service, and many in the transportation of gasoline and other petroleum products, this feature may be dismissed at once.

DETAILS OF EQUIPMENT.

In view of the fact that this particular equipment was probably the first to be put in service, and that it has proven highly satisfactory, a rather detailed description of it, and of the manner in which it has been used, is given.

Figure 1 shows the truck with tank of milk being unloaded at the main factory. The truck has a rated capacity of 5 tons, and the tank has a capacity of approximately 10,000 pounds of milk. The diameter of the tank is 47 inches and the length is 13 feet 8 inches. In the center of the tank is a manhole 16 inches in diameter, having a hinged cover arranged so that it may be closed, air or steam tight. In the cover is a vacuum valve, a relief valve, and a half-inch hose connection, the vacuum and relief valves being protective devices, and the half-inch hose connection being for the application of compressed air and steam, the uses of which will be referred to later. The tank is provided at the bottom with a 2-inch outlet valve and sanitary connection.

The main body of the tank is of tinned copper, the sides and ends being of 54-ounce and 64-ounce material, respectively. The sides of the tank are next covered with wood staves of $1\frac{3}{4}$ -inch material, and around these, arranged so that it may be drawn tightly around them, is No. 18 gauge galvanized iron. The tank rests on two so-called saddles, of wood construction, which are held in place by means of iron bands passing around the tank.

On the truck is a regular stake body, and the two saddles are so arranged that they will engage with the stake pockets of the body when the tank is placed on the truck. With this construction the tank may be readily hoisted from the truck in a garage where provision for such removal has been arranged. The truck with the tank is backed into the garage, chains are hooked into four rings provided in the saddles, and by means of two chain blocks the tank is raised about 6 inches. The truck is then driven from under the tank, after which it may be used in the transportation of other freight.

This particular truck, in traveling 89,000 miles, has transported 85,118,028 pounds of freight. During a single month this truck carried 1,586,610 pounds of milk and 711,551 of other freight, or a total of 2,298,161 pounds. The cost of operation per mile traveled is approximately 42 cents, which cost includes wages of the driver. It may be said at this point that cost of truck operation depends very greatly upon the treatment the truck receives in lubrication and in method of driving, as well as upon the condition of the roads.

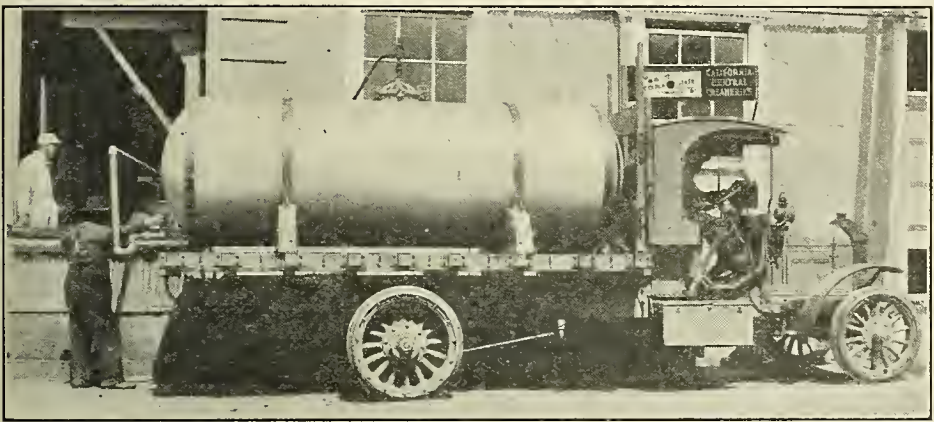


FIG. 1.—Motor-truck tank of milk being unloaded.

This particular truck has been operated largely upon graveled highway, which at times at least has been very rough and uneven.

MODE OF OPERATION.

In operation, the truck with tank is taken to stations where the milk has been received from the farmers, cooled, and placed in large retaining vats. The milk is pumped or flows by gravity from these vats through the manhole into the transportation tank. When the tank is full, or when the entire supply of milk has been taken, the manhole is closed and the truck is driven to the manufacturing plant.

It being desirable to ascertain the weight of milk arriving at the main plant, truck scales have been installed there. When the loaded truck reaches the plant the gross weight of truck and milk is taken. The truck then moves forward to the place arranged for delivery, sanitary 2-inch pipe is connected to the outlet, and an air hose is attached to the hose connection on the cover. The outlet valve is then opened and compressed air is applied. Ten pounds of air pressure will remove the 10,000 pounds of milk in about 18 minutes. The relief valve in the manhole cover prevents the application of

excessive air pressure in the tank. All but about 4 ounces of milk may be removed from the tank by such procedure. After unloading, the truck is again driven onto the scale and weighed, the difference between first and second weights, of course, being the weight of the milk delivered. This method of weighing has been found to give results fully as close as those obtained by weighing the load in divided portions in the usual factory weigh-can equipment.

SECURING REPRESENTATIVE SAMPLES OF MILK.

In addition to having the weight of the milk, it is also desirable to secure a representative sample. Various methods for taking such samples have been tried, such as by means of tube and dipper; however, the procedure found to give most nearly representative samples has been the placing in the sanitary tube through which the milk flows of a $\frac{1}{16}$ -inch tube, which, as the milk is forced from the tank, allows a small stream of milk to flow from this tube into a suitable container provided. The amount of milk so collected from a tank full will be about 2 gallons. From this amount a sample of the size desired for examination is taken by means of dipper or tube.

CLEANING THE TANK.

The necessary equipment for washing the tank is provided in a garage. The truck and tank are backed into the garage and, in the event it is desired to use the truck for other service, the tank is lifted from the truck in the manner already described. When this is done, rather than leaving the tank suspended during the period of washing, it has been thought safer to have it rest on suitable supports of the right height, which are moved under the tank, the tank then being lowered a few inches until it rests firmly upon these supports. The operator washing the tank is provided with rubber boots or suitable rubber-soled shoes which are used only when entering the tank. The operator is not permitted to walk on cement or gravel floors with such boots or shoes, for sanitary reasons, and also because sand or gravel would become embedded in the rubber soles and would damage the tinning of the tank.

The operator enters the tank through the manhole, taking with him a bucket of alkali water (solution of sodium carbonate), a brush having suitable handle, and a water hose. Valve connections whereby the operator may secure either hot or cold water through a hose are provided within easy reach from the manhole.

The inside of the tank is first rinsed with cold water, then thoroughly washed by means of the brush with the alkali water, and finally rinsed with warm water. The operator now comes from the tank, closes tightly the manhole lid, attaches a steam hose to the hose connection provided, and turns in live steam. The outlet valve is then very nearly closed, being left sufficiently open, however, to permit the condensed water, air, and a small amount of steam to escape. Steam pressure of 15 pounds per square inch is permitted to develop and is continued for 20 minutes, which results in practically complete sterilization of the tank. Pressure beyond 15 pounds is prevented by means of the relief valve. After the sterilization has

continued for the 20-minute period, the steam is shut off and the tank is permitted to cool without further treatment. It is during the cooling period that the vacuum valve in the lid comes into play in preventing the formation of a vacuum in the tank.

TANK AS COMPARED WITH CANS.

This tank has a capacity equivalent to one hundred and twenty 10-gallon cans, which is the size most generally used throughout the United States for transporting milk. The tank has a gross weight of 2,500 pounds, while one hundred and twenty 10-gallon cans of usual construction would weight about 3,240 pounds (at 27 pounds each). The manual labor required for filling, emptying, and washing 120 cans is very much greater than that required in connection with the tank. Again, the waste of milk is reduced to an extremely small percentage by means of the tank, while considerable waste seems unavoidable when using the small containers. The possibilities of contamination from the cans are very much greater than from the tank, especially if the tank is cleaned and sterilized in the manner described. Surface contact alone is 4.6 times greater with the cans, the inside surface of a 10-gallon can being 6.6 square feet—or, for 120 cans, 792 square feet—as compared with a surface of 171.6 square feet in the tank.

The cost (San Francisco quotations) of 120 cans at this time would be \$480, as compared with the cost of \$855 for the tank. Rather reliable indications are that a tank should have a useful life equal to the life of three sets of cans.

MATERIAL FOR CONSTRUCTION OF TANK.

As has been stated, the foregoing is a rather detailed description of the construction and use of a particular equipment. Milk tanks of different design and constructed of different materials are now in use, some being constructed of tinned copper, others of enameled iron—the so-called glass-lined containers. Excepting for the greater weight of the glass-lined tanks, they are probably superior; however, in all matters of transportation weight is one of the very important considerations, and such additional weight may more than offset the other advantages.

WHERE MAY TANKS BE USED?

It is believed that tanks used in connection with motor trucks have a very definite place in the transportation of milk after it has been collected at receiving station. It is, however, doubtful if taking the truck and tank directly to the farms and attempting to weigh, sample, and transfer the milk from the containers used on the farms to the transportation tank will produce satisfactory results. Attempts at such procedure have been made but were soon discontinued.

WHAT DISTANCE MAY MILK BE TRANSPORTED?

The writer's observations have been chiefly in connection with the transportation of milk relatively short distances—from 4 to 12 miles. The shortest distance would be that distance from the main plant at which it would seem practicable to establish a receiving station.

The greatest distance the milk could be economically transported would probably depend in large measure upon highway as well as railway facilities. Even where highways are good, beyond certain distances time becomes a limiting factor, in that the speed of the truck must be limited to 10 or 12 miles per hour in order to keep repairs and depreciation, not only of the equipment but upon the highway as well, within reasonable limits. Time becomes the limiting factor in determining the distance over which milk may be carried, only in the case of milk intended for city milk supply; with milk intended for manufacturing purposes, the factor which limits hauling distance is the cost of transportation. At this time milk for city consumption is being transported a distance of 150 miles.

EFFECT OF TRANSPORTATION ON MILK.

Careful examinations have failed to reveal any unfavorable effects on the milk. It is reliably reported that milk is transported a distance of 150 miles in insulated glass-lined tanks with a rise in temperature of only 2° F., with a temperature difference between milk and atmosphere of approximately 35° F.

Chairman WILLS. Now, gentlemen, the subjects are open for discussion. Let us have a full discussion on this matter so we will have a good digest of it.

Mr. O'CALLAGHAN. I have been privileged to help lead in the discussion, and I would briefly summarize the methods obtaining in Australia in connection with the proper distributing of milk.

As most of you know, distances are long and temperatures are fairly high throughout the dairying portion of the country. First, then, you can realize that in order to get satisfactory results over any distance we must have, primarily, conditions that are good in comparison to those where the milk is transported only short distances as in England. Therefore, one of the first things which the authorities in connection with dairying lay down is that every dairy farmer that sells milk for any purpose, whether for drinking purposes, butter making or cheese making, or any other purpose, must pass an inspection before that man is allowed to produce milk, and on passing that inspection he is registered as fitted to sell milk to the dairies.

One of the main features of that is the equipment in the place where the cattle are milked. That place must be of concrete or other impervious foundation, and our milking sheds are entirely separated from our feeding sheds. Generally speaking, we do not require the feeding sheds because the cattle graze throughout the year out of doors, and the housing of the cattle would not be 1 per cent of production, and only then in the cold weather or in the colder portion of the country.

Next, the cattle must pass an inspection by a trained stock inspector. Then a farmer is equipped. That inspection is made at least once a year, and every dairy farm producing such products for sale in any part of Australia is inspected once a year.

The milk for the larger cities is drawn generally from the fringe on the east coast, with a close source of supply. Owing to the sparse

rainfall, we have had to draw our supply along the fringe of the coast. That means that we have to transport milk any distance from 50 miles to 150 miles, and sometimes in the time of drought over 200 miles. This is done by rail.

The work is done at the present time in this fashion: The farmer sends milk to the receiving station where it is Pasteurized. Secondly, the milk is then cooled down to a low temperature and held in holding vats, usually of the same kind you see here and which I think originally came from this country. Then the train comes along and pulls up to the factory (there are milk stations along the railway systems) and a tank is provided on the truck. These tanks in the first instance are supplied by the principal milk companies and not by the railways. The milk now gravitates from the holding tanks in the factory to the tank on the railway truck, and it is transferred from the factory to the city, from which point it is now pumped into a refrigerating holding tank in the large establishment. The milk is then held at a low temperature until sent out to the consumer.

The only check beyond the inspectorial check of the dairy farm is made by the inspector at the factory, because the factory understands, of course, any shortcoming on his part and it is taken up with headquarters in the city. The health authorities maintain, in addition to the others, an inspection bureau for the purpose of seeing that the milk is kept up to chemical standards of supply. So far, we have not had information from Doctor Williams as to whether a mere bacteriological count is satisfactory unless we have some classification as to friendly and unfriendly bacteria. Those of you who listened to a paper the other morning remember that the statement was made by one speaker that smears were taken of the milk morning and evening, and the result was taken from these smears. The smears in the evening milk would contain a very large number of lactic-acid bacilli and it really, from a bacteriological standpoint, may contain a greater number of friendly germs and be better than the morning milk which contained a very much smaller number of lactic acid germs. Therefore, I would think that Doctor Williams might help us along this direction.

I need not turn to the importance of the bulk tank which is sent to the railway station by some factory, except that it has come into considerable use of late. The sending of milk in individual cans has, practically speaking, passed away.

I would like to know if anyone here has experimented with the French aluminum can. I would like to hear of their experience with them. It is a can that holds about 10 gallons; there are no rivets or seams, which strikes me as being most sanitary.

Chairman WILLS. Are there any questions to be asked?

Mr. NATHAN E. LAZAMS (Lacteal Analytical Laboratories (Inc.), Buffalo, N. Y.). In the papers and the discussion there was nothing said about the methods of agitating the milk in the tank before it is drawn off. It is a natural tendency for the cream to come to the top, and I do not know of any mechanical contrivance in the tanks for that purpose. Would one of the gentlemen tell me about it?

Mr. GRAY. My personal experience does not cover that particular thing for the reason, as I stated, that the distance of our hauling is

very short. I think over a long period there would be some cream coming to the top, but at the low temperatures at which milk is transported I am told by reliable authorities that that has not been a factor. Not a distinguishing factor at least.

Mr. J. E. SIMPSON (the Elyria Enameled Products Co., Elyria, Ohio). There are two methods of handling tank trucks where the cream rises. One is a mechanical agitator which runs from the axle of the car, and the other is to open a manhole and take a paddle and stir it before unloading.

Mr. GALLAGHER. In handling milk in tank containers we have not found it necessary to put agitators in by virtue of the fact that, in shipping, the motion tends to keep the milk well stirred, and the location of the tank on the trucks is such that it automatically, from the motion of the trucks, keeps the milk well mixed. The motion of the car back and forth also has the same effect. However, I understand that on the tanks used for long hauls there is a sort of agitator.

Mr. G. C. WHITE (Connecticut Agricultural College). The subject has dealt considerably with tank cars, but I feel that some of us feel that it has not covered the whole ground quite sufficiently. In the discussion this morning it has been assumed that shipping by tank car has eliminated a lot of the labor—in washing cans, for instance. Of course, that milk must originally be put in smaller cans and transferred to the receiving station. In this part of the country a great deal of the milk is picked up in comparatively small amounts at places where the train stops. I can also see that some work will need to be done with reference to having those cans properly sterilized. That will fall back to the responsibility of the farmer or the dairyman, and I just wondered what experience has been met with along that matter of properly cleaning and sterilizing cans on the farm. Has the bacteriological count changed any on this account?

Chairman WILLS. I do not think that question should come under the head of this meeting. This meeting deals with the transportation of milk in bulk, where it is shipped to the larger cities at a distance of 150 up to 200 miles, or as, in some parts of the country, as far as 400 miles by rail, and in quantities of 100,000 pounds or more. That is the question before us to-day.

Mr. E. G. MINER (Rochester, N. Y., vice president of National Dairy Council): I think the Baltimore & Ohio Railroad has quite a compilation of figures covering this matter, and I would suggest that we allow the gentleman to refer to those records.

Chairman WILLS. Have you those figures with you, Mr. Dugan?

Mr. DUGAN. I think that is very interesting, but I haven't the figures at my disposal at just this time.

Mr. MINER. I think they are very interesting, Mr. Chairman, and if I may be so bold, I had the pleasure of consulting them some time ago.

Mr. DUGAN. I did not anticipate answering that question, but I will go over them after the session is over if he wishes.

Dr. STENHOUSE WILLIAMS. I might say that in England we do not rely on the microscope for our tests. We use the plate method of examination for the general count, and we control that by an examination for their coli-form organism count, and we expect our milk to

reach us in such a state that this organism is absent in a definite amount of the milk, and I think we have eliminated that trouble. We have also eliminated that trouble in another way by discarding the first squirt or so before we begin milking. Because it is in the cistern of the cow's udder that the trouble arises.

I wish to say that I have a great deal of sympathy with Professor White. I do not recall that any of these papers have dealt with the situation on the farm or that any steps have been brought before this congress of what you are doing on the farm. Even in Australia I am told the dairy farmer is licensed on his milk.

One speaker in his talk mentioned the fact that he had two sterile vessels. He said that the tank was sterilized and smelled sweet, but still there was that odor when the can was opened. It seems that there is quite a misconception of what is meant by sterility; and if such is the case, back to the farm we must go. I believe there is a great future before us. It appears to me that the tank has great possibilities. I want very much to know what is really done at the places where the milk is put through the churn; I would like to know whether the notion of sterility existing in those dippers is similar to the notion of sterility in the can offered to us at this meeting. [Applause.]

Chairman WILLS. Our next subject will be of interest to all of us, "The costs of milk delivery," by Mr. Asa B. Gardiner, president, Western Maryland Dairy. Mr. Gardiner. [Applause.]

Mr. A. B. GARDINER. I would like to digress a little bit before going into my paper. The transportation of milk has improved tremendously. It is a great thing that the transportation companies are doing, and I, for one, have been studying to get some reason for this distinct interest on the part of our transportation companies. It occurs to me that this thing really began some 30 years ago. I think it started in this way: Commodore Vanderbilt was tired of our New York Central Railroad. One day a man was ushered into his office. The condition of his collar, the condition of his cravat, the look in his eyes, the shape of his head, things that most of us look at, impressed the Commodore. The man said, "I have a great thing. It would make you a fortune. All the milk in New York City comes from Orange County; let's pipe it in!"

You see what that has done, don't you?

THE COSTS OF MILK DELIVERY.

ASA B. GARDINER, president, Western Maryland Dairy, Baltimore, Md.

The expenses of the milk dealer incident to the delivery of milk are but little known to the consumer, who has no concern in those details, however vital their importance may be to the dealer himself.

Uneconomical management is disappearing from the milk business, and in the larger cities of the United States and Canada it is now evident that only those organizations that have a large volume of trade, and practice efficiency and economy, continue to exist. In those cities the small dealers, after unprofitable years, are succumbing to the present narrow margin of profit on investment.

Due to the trend of business toward small profits, it is expedient for the dealer to study the unit costs of production and handling

per quart. In the course of a month or year, a slight fractional saving per quart, when multiplied by thousands or millions, becomes an estimable sum.

Few dealers use bookkeeping that will show them the unit costs for the many individual operations incident to selling milk.

The dealer has four major costs, and all expenses should be chargeable to one of these four:

1. The cost of the raw milk and its delivery to the plant.
2. Production costs. Under this heading come labor and supervision, inspection, Pasteurization, bottling and capping, refrigeration, heat, supplies, repairs, bottles and their cleansing, etc.
3. Selling expense.
4. Administration or overhead expense. These costs include taxes, insurance, and depreciation, salaries of executives and bookkeepers, legal service, and many miscellaneous items, such as telephone, telegraph, stationery, etc., not chargeable to the other groups.

The proportionate division of costs, after subtracting the first cost of the raw milk, is approximately:

Selling costs equal 55 per cent of total costs.
 Production costs equal 30 per cent of total costs.
 Overhead costs equal 15 per cent of total costs.

A more detailed division, where milk was 13 cents per quart, was:

	Cents.
Farmer	7½
Dairy employees	2½
Merchants supplying bottles, fuel, feed, etc., taxes, insurance and depreciation	2½
	12½
Investors received	½
Total	13

Delivery costs are greatest and therefore of major importance. The first consideration should be the volume on the delivery wagon. A study made some years ago is still an index to successful management. The following results show the quarts per route per day and the margin between the average first cost of the milk and the average selling price:

City.	Load per route.	Margin.	City.	Load per route.	Margin.
	Quarts.	Cents.		Quarts.	Cents.
Ottawa	550	3½	Baltimore	335	5½
Philadelphia	410	4½	New York	265	7½

These loads, multiplied by the margins, closely approximate the same result, but it is evident that the dealer with the largest volume per route, is able to operate with lowest expense.

Selling expenses cover the deliveryman's wages, wages of extra men and helpers, hostlers, mechanics, etc. The deliveryman's wages are paid in the following ways:

1. Straight salary per week.
2. Small salary and commission on sales,
3. Commission only.

It is the deliveryman's duty to distribute the products, collect the empty bottles, settle accounts, and care for his horse and wagon or automobile. These men are expert sales and delivery men. They spend from five to six hours daily delivering the milk, and on collection days they are on the route for 10 or 12 hours. They are not required to do hostler work, but they do keep the accounts for their routes.

Figures show that the delivery men are getting practically the same salary per week on any one of those three systems. On the routes where the man is getting a straight salary equivalent to as much as 11 per cent and has built up his route to a fine figure, and has really reached the point where no more can be added to that route, if the company sees fit to cut that route and divide that out on a straight commission basis, we have found that route men were extremely dissatisfied. But on a fair guaranty, plus a minor commission, you could make your rearrangement with less dissatisfaction. I want to say here and now that many a man in the milk business does not realize that his route service is his main means of income, and that it must be handled fairly, kindly, and with discipline and justice, or else that business is headed for trouble.

Good cost accounting is required in the milk business and the International Association of Milk Dealers has prepared a cost-accounting system suitable for milk dealers. This may be used to an advantage and with a minimum of cost and effort by the dealer with a few routes. Another important feature of this system lies in the opportunity for dealers to compare their unit cost with one another.

When it is realized how quickly costs multiply, the importance of cost accounting in milk delivery becomes obvious. For instance, if a milk dealer with 200 routes lost, through leaks, accidents, or unnecessary costs, \$1 per route per day, at the end of a year he would face a big loss, amounting to 200×365 or \$73,000.

The milk business is a great and growing industry. On it depends the health and comfort of the community served; and of all industries, it would appear to the speaker, the milk industry has assumed the full responsibility for performing this public duty as a moral obligation.

Chairman WILLS. Is there any discussion on this subject? If not, the meeting stands adjourned.

(Adjournment.)

SESSION 17. MILK IN THE DIET.

Honorary chairman, Dr. J. MAQUET, Commission for Relief in Belgium, Educational Foundation, Inc., Brussels, Belgium.

Chairman, Miss MARTHA VAN RENSSELAER, head of the department of home economics, New York State College of Agriculture, Cornell University.

FIRST BAPTIST CHURCH AUDITORIUM,
Syracuse, N. Y., Monday, October 8, 1923—9.30 a. m.

Chairman VAN RENSSELAER. It is our pleasure to have with us this morning as honorary chairman Dr. J. Maquet, of the Commission for Relief in Belgium.

(Doctor Maquet spoke a few words in French.)

Chairman VAN RENSSELAER. Doctor Maquet, who has just spoken to us in a language not known to all of us, is a representative of the Belgian Government, in charge of the children's colonies in Belgium, or the vacation schools.

It was my good fortune to visit those colonies this summer and to become very much interested in the good work that Doctor Maquet is doing. We believe it is a very great credit to Belgium, and we wish that the persons in the United States and in other countries who are interested in child welfare might have the opportunity to see the work which is done by the Belgian Government for its children.

It is quite possible that there is a French interpreter in the room. Is there?

(No response.)

I am sure all of you would have been interested, if you do not know the French language, to know what Doctor Maquet has just said to us.

I am very glad to introduce to you Miss Marion Moseley, who is the director of the child welfare department, International Grenfell Association, Labrador. Miss Moseley will speak to you on "Nutrition work in Labrador."

NUTRITION WORK IN LABRADOR.

MISS MARION R. MOSELEY, director, child welfare department, International Grenfell Association, Labrador.

It is a great pleasure for me to be able to tell you something of the child welfare work which has been carried on during the past four years under Dr. Wilfred T. Grenfell's mission in Labrador, for we are so grateful to the National Dairy Council for the splendid support they have given us. A year ago the National Dairy Council in Chicago most generously supplied the school teachers and nutrition workers with copies of their pamphlet, *What Milk Will Do for Your Child*. This year they increased their donation to include 1,000

copies of all their material, which we found especially applicable to conditions in the north. Also this year the Philadelphia Interstate Dairy Council greatly contributed to the success of the summer by sending their worker, Miss Edith Howes, as nutrition supervisor of the health program carried on in the schools along the Labrador coast. We owe very much to the cooperation and kind interest of both Mr. Maughan and Mr. Balderston.

Before going to Labrador, I had seen the need of milk for children in this country during my work with both Dr. William R. P. Emerson, of Boston, and the Elizabeth McCormick Memorial Fund, in Chicago, but never to such a great degree as in Labrador. There children were existing solely on white bread, fish, and strong tea. I remember one small child who had daily as many as 20 cups of tea which had been steeped so long it was the color of coffee. This diet, lacking so many essential elements for growth and health, was mainly responsible for the spread of deficiency diseases, beriberi, scurvy, and rickets. Tuberculosis is even more prevalent and, without more nourishing food, one can only predict that the underweight child will eventually succumb to this disease, as will, in many cases, both his parents.

It was quite evident that, if the children were to build up any resistance, additions must be made to their diet. Some of these additions could fortunately be found at hand. Every effort was made to use native products which had been neglected through ignorance. Cod oil was very plentiful, cod fishing being the main industry, yet the parents had never heard the rhyme now popular among the children, "Take some cod oil every day, and you will keep ill health away."

Livers, wild vegetables, such as dandelions and dock, and also wild berries could be used in preventing scurvy and beriberi. We were also able to introduce oatmeal and whole-wheat flour through the trader at a price no higher than white flour. But after seeing, on every hand, children weaned on bread and tea, the introduction of milk seemed fundamental to any real solution of the problem.

[Lantern slides.]

I. PEOPLE AS WE FOUND THEM.

1. Family with symptoms of scurvy who did not know that cod oil and cod livers, which they had in abundance from the codfish industry, would prevent and cure scurvy.

2. Mother and two children. Father in hospital with beriberi. Child of 14 and baby had died during the winter of beriberi, yet mother and two remaining children were still living on white bread and tea, not understanding that on that diet they must eventually succumb to the same disease.

3. Three boys, all pronounced mouth breathers, needing both tonsil and adenoid operations.

II. HEALTH CLASSES.

1. Nutrition class attended by children from 3 to 16 years old, and their mothers.

2. Nutrition picnic. Children given whole-wheat bread sandwiches with lettuce filling.

The first year our equipment for the Labrador work consisted only of scales, simple charts, and record blanks for nutrition classes, and a little dried milk, as we did not know the other things needed to cope with the situation. How glad we were that we had even

that small quantity of milk, for it was the means of educating both the children and their parents in the value of milk as a food. Extra lunches of dried milk were given to the children in mid morning during the summer. At first they did not like it on account of its novelty, but after two or three days the cups which at first had been pushed away almost untasted were eagerly passed back for a second and third filling.

[Lantern slide.]

Mid-morning lunch of dried milk.

This education in the food value of milk was continued during the winter in the school at St. Anthony. At recess each child was given a hot drink made largely of dried milk and flavored with cocoa.

Fifty per cent of the children of that vicinity were in an under-nourished condition when we started—the same proportion as that of Newfoundland and Labrador men who were found physically unfit for service during the World War. The complete physical examination showed that of 73 children enrolled in the nutrition class, the majority required dental care, and that 24 needed to have tonsil operations to make them free to gain on the extra milk lunches and dietary changes.

These defects being corrected as early as possible in the summer, the whole group gained three times the normal rate before fall and persevered so well during the winter that one-half were up to weight by the next summer.

[Lantern slides.]

PHYSICAL DEFECTS CORRECTED.

1. Hospital, where complete examination was made of each child and physical defects corrected.
2. Girl, whose tonsils were so enlarged she had not been able to eat anything solid for three months previous to tonsil operation. She was delighted afterwards when she could eat normally again.
3. Boy, who had been stunted in growth by toxic tonsils. He was the same height as his brother, two years younger. He started gaining after the operation was performed.
4. Girl, whose father asked why we wanted her tonsils removed when the Lord had given them to her.
5. Dentist, drilling children in brushing teeth.

The gains made were a sufficient object lesson to induce the parents to desire a constant milk supply. The people can not afford to buy canned or dried milk on account of the very high duty. Cows here are out of the question because of the scarcity of hay. Goats seemed to be the only solution to the problem, as they have thrived wherever the voracious Eskimo dogs have been penned. Fortunately, in St. Anthony the dogs had already been confined, so that, as a direct result of our milk propaganda, 12 goats were ordered the following summer.

[Lantern slide.]

Dog pen.

In 1921 our staff was increased to seven health workers, trained under Doctor Emerson, as compared to the two workers the first year. We had six centers instead of one and reached 252 children

as compared to 73. Our additional equipment consisted of tooth-brushes, health charts, and vegetable seeds and a larger quantity of dried milk.

The work was enlarged at two of the stations to include a baby clinic in addition to the nutrition classes. Public food demonstrations were given and a garden day was held at the end of the summer, when the children brought specimens of what they had raised from seed in their gardens. Three hundred and sixty-nine children benefited by medical examinations, as compared to 73 in 1920, and 33 more tonsil and adenoid operations were performed—there having been 24 the previous year. In two places the children had dental care.

[Lantern slide.]

Member of baby clinic.

The most important development of the summer was a campaign to pen the dogs at Spotted Islands, a station on the Labrador Coast, staffed and financed by the college of physicians and surgeons of Columbia University. The object was to make the place safe for goats. The children had had dry milk at mid-morning lunches that summer in the school, and illustrated health talks were given several times in the evenings. Then a meeting was called one Sunday afternoon so that all the fishermen might be present. Did the people of Spotted Islands want their children to continue to gain the way they had during the summer on dry milk, and would they take the necessary trouble in order to obtain goats? These were the questions we frankly asked them. Each man who was willing to cut logs in the interior during the winter and, after bringing them out by dog team, build a pen for his dogs, was to signify his intention by standing. It was some time before they realized the significance of what was asked, since the process of voting was unfamiliar and they had never conceived the necessity of shutting in their dogs, but before we left the school every man had risen to his feet.

The children as a whole, in spite of several epidemics this second summer, gained over twice the normal rate for their age.

The following winter we sold Christmas cards and raised a fund to buy goats in southern Newfoundland to be sent to Labrador. We found that they could be purchased for about \$15 apiece. But the discouraging thing in introducing common goats was that they give only about a couple of pints of milk a day. During the winter we heard of the Swiss Toggenburg goats. These originally came from a cold Alpine climate. They give as much as 2 gallons of milk a day, and when crossed with scrub goats the milk yield is the same after three generations. It seemed to us that if we could get a strain of this fine stock up on the Labrador coast, that would be one of the big ways of introducing a milk supply there.

At first it seemed like a dream that could never be realized, as a thoroughbred Toggenburg may cost as much as \$2,000, but through the generosity of Mr. Charles A. Stevens and Mr. F. C. Farwell, of Chicago, we have been able to introduce 16 of these beautiful animals.

The 3-months-old does we took north a year ago each had two kids this spring, and are now giving as much milk as a cow.

[Lantern slides.]

INTRODUCTION OF TOGGENBURG GOATS.

1. Goats on shipboard.
2. "Prince of Agawam," highly pedigreed animal.
3. Kids having first lesson in butting.

In 1922 the work was extended to take in seven centers, as compared to six the year before. Also the 25 summer schools for the first time were given a definite health program, the initiative having been left before to the individual teachers. This was made possible through the kindness of Doctor Emerson, who gave a special course of lectures to the teachers stopping in Boston on their way north and also supplied them with pamphlets, health charts, and outlines for conducting health clubs. The latter were especially adapted to Labrador conditions by Doctor Emerson and Dr. E. V. McCollum, of Johns Hopkins. Correlation of the work on the coast was obtained by means of two traveling health units, each composed of a doctor and nutrition supervisor, with one dentist and industrial worker in addition. This was the first time a doctor had visited all the schools under the Grenfell mission. Nine hundred and eighty-one children were given thorough physical examinations, and 68 necessary operations were performed during the summer.

[Lantern slides.]

I. WORK OF TRAVELING NUTRITION UNITS IN CORRELATING SUMMER SCHOOLS WITH GENERAL HEALTH PROGRAM.

1. Means of travel by small boat.
2. School teacher and children.
3. Doctor examining child.
4. Cooking whole wheat flour pancakes to demonstrate value of whole wheat flour in fighting beriberi.

II. THE APPRECIATION OF THE PEOPLE.

1. Mrs. Clark, who saved eggs from one hen for days before our arrival, in order to have something special to give us.
2. Family who moved the garden in order to remodel house for our comfort. The father walked 32 miles, spending his meager earnings, to buy a small can of food from a trader for a treat when we came.

It was the education by means of colored pictures, lantern slides, and valuable health material which was responsible for our success in introducing 66 goats during that summer. The dairy council pamphlet on "What Milk Will Do for Your Child" was a most effective instrument. As soon as the people saw the beneficial results of a constant milk supply they contrived various means to bring it about. One cove agreed to put their dogs on an island; another to shut them up during the day and let them out at night when they penned the goats; and others resolved to make inclosures as soon as possible.

Seventy-three per cent of the children found in these outlying districts were underweight. Three hundred and eighty-six children that year were in health classes and made an average of four times the normal rate of gain—the best record we had ever had.

[Lantern slides.]

RESULTS OF HEALTH TEACHING.

1. (a) Girl who had beriberi symptoms when she entered nutrition class.
- (b) Same girl one year later, when she graduated from class after gaining 32 pounds.
2. School children on deck of boat returning from hospital center where the eye specialist had fitted them with glasses. They were delighted because for the first time the letters of the alphabet did not dance up and down on the page.
3. Boy, whose father wanted to "make a man of him quick." He had been going to bed at 10 o'clock and getting up at 4.30 and his work had been to carry two full pails of water about one-eighth of a mile as often as 10 times a day. On examination the boy was found to have a double heart leak, the sound of which could be heard 12 inches from his body. He was short of breath, pale, had no appetite, and was 27 pounds underweight. By having him go to bed at 8 p. m. and not get up until 7 a. m. and lightening his daily work, in two weeks, at the time this picture was taken, he had already gained 14 pounds, had an appetite, and rosy cheeks.
4. Three boys in one of the coves where they had milk lunches for the first time that summer.
5. Little girls taking milk to school the morning after the lantern slides on health were shown at the schoolhouse.
6. Boy, who learned to like lettuce. At the beginning of the summer he had ripped the lettuce out of a sandwich saying he did not like "hay." But he learned to like it, and was seen later eating a handful of lettuce just plucked from the garden.
7. (a) Myrtle Mary, a little girl who was 18 per cent underweight the first year. She followed the program advised by the nutrition class and gained 12 pounds.
- (b) Myrtle Mary, the following year. Her grandmother said, "She 'is a different girl; her whole disposition has changed; it's as if the dead had been brought to life."
8. (a) Underweight children sent to hospital for tonsil operations.
- (b) Same children year later, all up to weight.
9. (a) Girl thirty-two and a half pounds underweight (38 per cent) started on road to health in 1921.
- (b) By the following summer had gained 36 pounds and grown 2.8 inches.

This past summer we have had three very large nutrition centers, supervised by Miss Ann Logan and Miss Mary Card, of the Elizabeth McCormick Fund, in Chicago, and Miss Ruth Wendell, formerly with the Chicago Tuberculosis Institute. Each of these workers did a very fine constructive piece of work. Miss Logan used the red, blue, and white tags to indicate whether the children were badly under weight, slightly, or normal. The parents would clap whenever a child received a white tag. A grandmother who had not appeared at class one day came immediately afterwards because she said she had heard the clapping and could not wait to see which child had received a white tag. The children treasured their tags, bringing them to class wrapped in bits of newspaper, and even the fishermen up and down the coast talked about what colors their children had.

The credit for the most successful summer we have ever had in health education in the schools along the Labrador and west coast of Newfoundland is due to our two supervisors there, Miss Edith Howes, of the staff of the Philadelphia Interstate Dairy Council, and Miss Elizabeth Criswell, of the Philadelphia Health Council and Tuberculosis Committee. With untiring effort they traveled by small boat in almost continuously rainy, cold weather from cove to cove in their territory.

The outstanding results of the work of the west coast unit, under Miss Criswell's supervision, were that for the first time along that portion of the coast dental service was given to 665 people (two-thirds being children) and adequate lenses were used to test eyes so that glasses were ordered for over 40. Forty children, from coves where physical defects had not been corrected before, were also sent to a hospital center for tonsil and adenoid operations. But the most far-reaching step in health education was made through securing the cooperation of two local missionaries in introducing a health program in the winter schools taught by Newfoundland teachers in their territory. Miss Criswell is supervising the work by correspondence this winter and there is every reason to hope that as a result better health standards will filter up and down the coast.

The Labrador unit, under Miss Howes' supervision, obtained as striking results in giving dental and optical service for the first time, and making arrangements for children needing operations to be taken care of at the hospital center. But quite the most amazing accomplishment was the actual introduction of 90 goats along the coast, which, with orders from other sections and the 11 thoroughbreds sent up from this country in June, make a total of 119 goats for the past summer. This is undoubtedly the greatest single achievement which has been made in our child welfare program for Labrador. It is a big step toward assuring the Labrador children a permanent milk supply. We should like to learn Miss Howes' technique, but strongly suspect it evolves from the dairy council stories of "Johnny Milk" and "The Good Health Fairies," which the people were never tired of hearing.

Both the nutrition centers and the traveling units were most fortunate in having as able assistants Dr. Irma Hauser, child specialist from New York; Dr. J. C. Anders, of the College of Physicians and Surgeons, and also two dentists of much experience, Dr. Edward Sullivan, of Boston, and Dr. Horace Lambert, of Waterboro, Me. Miss Olive Ferguson, a skilled dental hygienist from Boston, was also of the greatest service.

It has been impossible as yet to tabulate the gains the children made during the past summer, but a few instances will show, perhaps, even better than figures, the fundamental results.

A 9-year-old boy at Eddy's Cove could not talk plainly. The physical examination showed that he was tongue-tied. The doctor at once cut the tongue, and the boy was so elated over his ability to talk that he kept up a running stream of conversation. He even tried to sing, an accomplishment that he could not have succeeded in before.

One day the older children in the school at Port Saunders wrote a composition entitled "What I have done this summer to grow healthy." One boy handed in the following theme:

First in the spring we had doctor hear that clean teeth and sound us and anybody were sick they give them something to build them up. I am drinking cod oil now, eating some greens every day. I am taking a reast morning and evening. I am not drink coffee or tea. I drink milk in its place and I seem to getting along a wonderful lot better now since I have been doing these things that I learned in school.

One boy was found to have incipient tuberculosis. He was 20 per cent underweight, was instructed to drink one quart of milk daily, which he had never had before, take cod-liver oil and daily rests.

When the unit returned two months later John was reweighed and found to have gained $8\frac{1}{2}$ pounds. The disease seemed to have been arrested.

Milk is undoubtedly the greatest single benefit we have been able to give the Labrador children, and I believe that a place like Labrador, where there is no other nourishing food, makes the best laboratory to test the health values of dairy products. To the delegates from other countries I would like to make a suggestion. Why not interest the dairy associations in your countries to take a waste land like Labrador and make a definite study by testing the children before and after milk is introduced. When your figures are published they will not only prove to everyone the value of milk, but at the same time you will have the satisfaction of knowing you have advanced child welfare.

Chairman VAN RENSSELAER. Standing out very conspicuously in the United States is the work of the Elizabeth McCormick Memorial, of Chicago, and we are exceedingly glad to introduce Dr. Caroline Hedger, member of the staff of the Elizabeth McCormick Memorial Fund, whose subject is "Milk and health."

MILK AND HEALTH.

CAROLINE HEDGER, M. D., member of staff, Elizabeth McCormick Memorial Fund, Chicago, Ill.

Madam Chairman: Perhaps some of you have seen that touching and really beautiful poem which depicts a herd of little animals leaping and frisking along beside the aureoled saints in Paradise, and these little animals are depicted as the lesser martyrs. They are the little animals that have given up their strength and their vitality and their very lives to make plain the path of health and well-being for us. I think it is a very beautiful conception and a recognition of the part little animals play in our health program that should be widely known, but when I began to get up this paper on milk and health at the behest of the program committee, I concluded that if our present state of mind continued the aureoled saints would be very much in the minority, and they would be frisking alone in a zoological Paradise, because it seems to me that at the moment we are very much tied to the idea of nutrition in small animals. Do not misunderstand me. Small animals are protoplasm, so are we, and the fundamental problems of protoplasm must necessarily be worked out in small animals, but I want to begin my work with you this morning by a prayer that we do not confine ourselves too closely to small animals.

I don't know whether or not any of you know our Mary Murphy, at the Fund. The other day she was speaking to me on the subject of animal experimentation and child health, and she said, "But Mrs. Rat doesn't take the children to the movies every night;" and as a matter of fact neither are the little rats subjected to any such scheme of education as that to which we subject our children.

Of course in the rat we demand certain standards of health which must be brought about by certain additions to the diet. That is

fundamental. The rat has to grow; so do children. The rat has to look well; so do children. The rat has at an appropriate age, to reproduce, but I want to point out that reproduction and the bringing forth of a healthy child is quite a different thing from the development of the family, which is the basis of our civilization, and I feel that at the moment we must, with our scientific basis of small-animal work, quite widen our view on the matter of health.

Of course, we are taking a step further in this animal experimentation. Cannon, in his masterly work, *Bodily Effects of Fear*, brings in the emotional side of animal life as affecting nutrition. That is a long step forward, but even Cannon's animals were not and could not be subjected to the numerous stimuli that affect us. However much enraged Mr. Cannon's cat may be at the sight of a dog, and however that may affect her digestion, she hasn't the worry of financial trouble or a raise in rent; she hasn't the grind on her nervous system of her step-relatives or her in-laws, so far as we know; and even with the addition of the masterly work of Mr. Cannon, I am pleading for a wider view of health and nutrition than the strictly necessary and fundamental nutrition of small animals.

You can see that the wider view of nutrition is necessary if you stop to think along your own line. Take the production of milk in warm-blooded animals—mammalian animals—all of close relationship, all protoplasm, and yet you know that the differences in the structure, both physical and chemical, of that milk are great. The different demands of health and development in humans compared to those of animals vary as widely.

The very boundaries of this health field have to be defined with this human element added to the necessary scientific element. You have but to think back a few years to know that our whole field of health has shifted its boundaries tremendously. We used to cure tuberculosis. Then, about two decades ago, in health work we began to prevent tuberculosis. There are many of you who antedate that prevention work. What are we doing with tuberculosis to-day? We are building up, by our scientific knowledge, organisms—folks—who are resistant to tuberculosis. That marks a change from negative to positive standards that I want to pause on for a moment.

The curing of tuberculosis in the human being is a negative thing. You never can bring that human back to absolute perfection. He is marked, he is scarred; all we ever expect to get is an arrest. That leaves your man in a negative state of health. He may or may not, according to circumstances, reopen that focus of tuberculosis. Any purely negative state of absence of diseases is negative health, however, and is insufficient. Of course, my own profession has for centuries bent its energy to the cure of diseases, and they have given up their lives and their strength to do it, but when you get a body only free from disease you are a very short way on the road to health as we see it to-day. We have to translate that absence of disease into something positive; something that makes in the human for efficiency and for vitality; something that makes the human able to take his place in society; that makes him endurable socially; that gives proper behavior; and that, in the child, produces growth and the possibility of normal reproduction, plus the raising of a family.

This is true in your own work. I find in some backward places still the absence of tuberculin testing of cows. They haven't even attained negative health. In other communities, perhaps a little more advanced, you find a farmer, as I did the other day, with a huge dairy farm, and he was all puffed up with the idea that every one of his cows was tuberculin tested. I was glad of that myself, but when I saw that man's farm I saw that that man had a long way to go. It was filthy milk, but that man was perfectly satisfied on the negative basis that his milk could not produce tuberculosis. That is better than nothing, I will admit, but we have to go a long step forward, and you people are seeing that step—everyone sees it.

We have to have a milk that protects the individual against the kind of things Miss Mosely has been showing you; we have to have milk in sufficient quantities to produce normal growth, normal development, and normal behavior, normal participation in society, normal glandular action, and that is the new field of health and milk—the positive field far more than the prevention of disease, far more than the absence of disease, including all the things that make for a normal individual in a social world.

Where are we in this health field, and where are you in your milk field? You know your milk field better than I do. As I get it, as I travel about, I should say that in the health field we were a very straggling procession.

Take Holt, in his new book, *Food, Health and Growth*; he is clear ahead—a simple, concise statement of food requirements and health requirements that anyone can read as he runs. I don't know of anything that has helped me more in the last month than that simple study—yet it is not simple. It is a comprehensive and thorough study of 106 well children by Holt, as to their diet; the study of the human; the study of the requirements of the human; the study of what the well human is doing. That is the head of the procession.

Perhaps no finer statement on positive health is in print than the first four chapters of that book of Williams, *Personal Hygiene, Applied*. People who see this positive health field and are willing to live up to it and obtain it constitute the leaders in the health procession. The tail of the procession is the person who, having access to these scientific facts that have been worked out with small animals and with such studies as Holt's, refuses to accept his responsibility and refuses to live up to what he knows.

Occasionally a fat woman comes to my office. I request her to cut down on her diet. She says, "Oh I work hard. I like to eat. I am going to eat. I don't care if I am fat." Well, she is an illustration of the tail of the procession. She isn't willing to accept her responsibility for the well-being of her body. She isn't the only one. There are some of the skinny ones who are just as bad, but the tail of the procession is made up of the persons who can get the facts that are already elaborated by our scientists, and who refuse to accept the responsibility of conscious living. Those make the tail of the procession.

In your field it seems to me that the procession is pretty near as straggling. I go into some of the rich western States and find whole counties inadequately tested for tuberculosis, whole counties with

low standards, and then I will find another county with 90 per cent of the milk up to standard. It makes a straggling procession.

It seems to me that our certified milk for children is the head of the procession, on the milk side. I don't know whether you milk people would agree with me or not, but that is the way it looks to me, as a doctor. While at the tail of the procession on the milk side is the advertisement of dead milk (by dead milk I mean milk subjected to heat of such intensity or even such a length of time that the growth value of the milk, the vitamins, are destroyed) and filled milk as children's food. I get almost to the point of frothing at the mouth in our street cars in Chicago, where dead—absolutely dead—milk is advertised as baby food; and of course there may be one more tailender, and that is the member of my own profession who prescribes such milk. But your field, your procession is almost as straggling as the health procession itself, and of course we only measure our progress by the time that the tail of the procession passes a given point, and it seems to me that it is up to all of us, both the health and milk workers, to hurry along the tail of the procession.

It isn't that we haven't leaders to show us the way. We have. It isn't that we haven't high lights to point out where we should go. But we haven't been comprehensive enough in our teaching to get the laggards up, and it leaves us in a rather dangerous state.

What can we do? What is there for us to do? In addition to these human studies of which I have spoken, we must have positive standards more widely given. So many people are willing to just scrape along in health. We have to make people see that health is not only a necessity for their own well-being and happiness, beauty—and I do use the selfish appeal—but we have to make them see that we are at a point where we can no longer carry them without health. I don't have to talk to an audience of this kind of the cost of sickness. I think it is \$17,000,000 a year that we pay in Chicago for our down-and-out, our sick, our mentally sick, our crazy, and our inefficient. How long can those of us who are responsible and on two feet and earning three meals a day carry that load? I think the laggard has got to be made to feel very sharply that we who are responsible refuse to carry the irresponsible and the voluntarily sick, the voluntarily inefficient; they may not even go the limit of sickness, but they may so feed or not feed that they are voluntarily inefficient. If you want a scientific clew to that, let me recommend McCarrison's Study in Deficiency Diseases, which I believe will give you a point of view on behavior in the value of nutrition that will be of value to you. It has been so to me.

This responsibility of ours—this immediate field—includes fundamentally, I believe, a wide educational campaign for a balanced diet. We have never undertaken a campaign of that kind, and if we really saw the necessity of a balanced diet for the individual I think we would put these "more" campaigns out of business.

I saw, I believe, yesterday, in my own bakery in Chicago, a sign, "Eat more bread—two slices a day," signed by Fleischman's yeast. That is absolutely a backward step in this campaign for health and for balanced diet. People who are above weight should not eat more bread—not two slices a day more; they should eat two less, and then some. And in the same way we can not run into these loosely han-

dled advertising campaigns that have as a basis, perhaps well-wishing for the community, but perhaps more, an economic return. Those are absolutely indefensible. Even on so valuable a constituent of the diet as milk, a "more milk" campaign is not to be tolerated. Your campaign must be an "enough milk" campaign—enough so that the necessary growth principles protect the child from these deficiency diseases that Miss Moseley mentioned. An "enough" campaign you will find me enrolling in. A "more milk" campaign I will have nothing to do with, because it is irrational in the point of view of controlled and balanced health development.

We know that milk is a necessity. We know that young things can not come to perfection without milk. What is our immediate business? Our immediate business is to institute a campaign of breast feeding in the human. That is the fundamental milk campaign, because the mother's milk in every animal is adapted to her child, and the human child needs human milk. That is the fundamental milk campaign, and you could make it a more interesting campaign almost than any other one I know of, by advocating adequate cow's milk to promote breast feeding in the woman, and that is our need at the moment. By adequate, I mean a cow so fed that the nursing mother receives the necessary vitamins.

There is some good work being done on breast feeding by the breast-feeding clinic at the University of Minnesota, Minneapolis. But this fundamental campaign of providing breast milk for all children includes a wide social campaign for the conservation of the girl. You have to take that girl from the development period on, and save her from the stress and strain of modern social organization and education and sometimes factory work. You have to see that girl as a future mother, and if she is to come into her high calling of motherhood she must be saved to the point where she can nurse the baby nine months. That is the milk campaign that interests me for the moment, first, and no milk on earth will make up for the breast milk.

[To Miss Moseley.] How is the feeding in Labrador? Do the women nurse their babies?

MISS MOSELEY. Yes; they have to; and they nurse them two years because there is nothing they can give them—and they are rickety.

DOCTOR HEDGER. Of course, to get this positive health there must be adaptation of environment and diet to the individual for his individual perfection, because that is the only basis of public health. Your public health depends on the health of the individual. Every individual is different; every individual demands study, education in fundamentals of health, and responsibility in right living. Beyond this we have the problem of the production of milk fit to drink, another educational problem, and of that you people know much more than I, but as yet unsolved.

Take that Indiana farmer with the filthy barns and yet who was so proud of his tuberculin-tested cows. It seems to me that a great organization like the dairy council could get across to that man some way, that those barns should be cleanly kept. I can not see why it can't be done, and I don't know how—I have no advice to give, I am a doctor, not a dairyman; I am giving the

problem as I see it, from my side of the fence, but it does seem to me that details will have to be harped upon.

I was reminded, as I was getting this together, of a funny experience of mine before the war, at the Kaiserin Augusta's House in Charlottenberg, Germany—the Empress had donated the cows to this home, and, of course, they were the most wonderful cows I had ever seen. They had tiled stalls and automatic water cups, which were to me strange at that time—and all the details for royal cows. But when I got into the kitchen of this place the milk was all being boiled, and I said to the man in charge: “Boiled? Why boiled?” “It's the only safe way.” I said, “Why?” “Bacteria.” I said, “If you had a milk with less than 5,000 bacteria, would you boil it?” “No. There is no such milk.” Well, I knew of a good deal of that kind in Chicago, so I said meekly that we had it in America. I backed up my own country to that extent. Then I hung around the rest of the day, wondering what was the matter with the Queen's cows. I stayed so long that I saw the milking—they were milking in open pails, with no special protection over the top of the pails, and then I saw why they boiled the milk. They had missed one minute detail that we see to in this country. That was before the war. They have probably come up on that point since.

It is the little things like that. How are we going to get the education across that the detail is what counts in milk production? And how are we going to get in that attention to detail and fit in that detail with the cost of milk? That is the problem, as I see it, for the great milk bodies, but it is a problem in which my profession is immensely interested. We know and feel the absolute necessity of milk of high grade and we know that we can not do anything in health without it.

I am a great believer in educational campaigns; and I believe if that Indiana farmer could be shown his responsibility to his neighbors, he would clean that barn. I believe a great many people are willing to take responsibility if the responsibility is shown them as their job.

I believe that in our health campaign in relation to milk with parents and children there is a definite place for the responsibility of the individual to be well. A child, I have found, reacts to a stimulus of that kind—the child wants to be superior. I use the superior appeal in dealing with children. They want to be as good as the next one and a little better, and I believe that you can easily bring into that the ideal of not being a burden to the community at large; being responsible; being a factor, not being a laggard, or a down-and-outer; being an actual part of the future. And I think that that should be included in our milk campaigns. It isn't to get so many pounds on that child's bones. It is a much wider problem, a problem of modern living and modern reaction. Now we can not do this if we are content with low standards ourselves. We can not do this if we feel: Well, it is all right to talk about these things, but what is the use? What if I do weigh 10 pounds too little or 10 pounds too much? Well, get it up to 20 per cent and ask the life insurance companies what they think about it. You will get a very direct answer.

It does make a difference whether you are at your highest efficiency—you, personally—because in all our communities the child is imitative, and the adult has to undertake this burden of responsibility for highest efficiency, highest health, normal glandular secretion, which comes from diet, and for normal behavior. The very imitativeness of your child throws back on us who have this thing in hand and in mind, the responsibility of being well ourselves.

Have in everything a vision of positive health that has a distinct relationship, not to our own happiness, but to the social field in which we live.

Chairman VAN RENSSELAER. We have had two very fine addresses this morning. I feel very certain that there should be some discussion—that you have some questions you wish to ask, and I should like, therefore, to give opportunity for discussing the first address, by Miss Moseley, or the second one, by Doctor Hedger.

In standing will you kindly give your name and your address?

It is quite evident that we agree perfectly with Doctor Hedger in her presentation. If you are quite sure you have no questions to ask, this meeting is adjourned.

(Adjournment.)

SESSION 18. CITY MILK PROBLEMS.

Honorary Chairman, Dr. FRANTIŠEK ROZINEK, Ministry of Health, Prague, Czechoslovakia.

Chairman, A. M. WORK, general manager, Portland-Damascus Milk Co., Portland, Oreg.

Secretary, J. W. BARTLETT, dairy husbandman, State of New Jersey Agricultural Experiment Station.

ONONDAGA HOTEL,

Syracuse, N. Y., Tuesday, October 9, 1923—9.30 a. m.

Chairman WORK. Gentlemen, the meeting will please come to order.

We have a full program today in regard to city milk problems, and on account of our late start it will be necessary to limit the speakers to 20 minutes each. We will notify them three minutes before their time is up so they will have opportunity to close within the limit. The good from these papers is going to come out in the discussion which we will have after the close of the papers.

It gives me a great deal of pleasure to introduce to you the honorary chairman of today, Dr. František Rozinek, Ministry of Health, Prague, Czechoslovakia. [Applause.]

Honorary Chairman ROZINEK. Mr. Chairman and representatives of the World's Dairy Congress: It is indeed a pleasure to me to preside at this meeting as your honorary chairman. I consider it also as a great honor to my country.

The city milk program occupies our ministry because, first of all, we must solve the problems in the great cities before we go into the other problems such as sanitation and the like. You all know that Czechoslovakia, as represented here to-day, is a country in central Europe and is called one of the most progressive countries of central Europe.

I wish only to ask that the governments which you represent here, and which recognized our independence five years ago, would recognize in the future the progressiveness of our great dairy industry in the field of production. I thank you. [Applause.]

Chairman WORK. The first subject on our program is by Mr. Ben Davies, of England, but as he is not present his paper will be transferred to the end of the session, to be read then if time permits.

Our next subject is "Problems by which the city milk dealer is confronted," by Mr. J. Le Feber, president, Gridley Dairy Co., Milwaukee, Wis. [Applause.]

PROBLEMS BY WHICH THE CITY MILK DEALER IS CONFRONTED.

JOHN LE FEBER, president, Gridley Dairy Co., Milwaukee, Wis.

Problems by which the city milk dealer is confronted are so closely allied with the health and development of our people that it is doubly incumbent upon him to function fully in loyalty to the industry and in his duty to mankind.

That, as all of us know, is not an easy task, because from the very beginning, the various factors of which our business is composed have lacked that spirit of unity so necessary to the welfare of any great commercial undertaking. This is to be regretted, although I firmly believe the time is not far distant when all such differences will become a negligible force. Then, indeed, shall we work as one to the lasting uplift of the industry, and to our own moral and material gain.

First, then, in considering these numerous factors, comes the farmer who, next to Nature, is responsible for the daily supply of milk upon which vast urban populations depend for sustenance and health. In speaking of the farmer, I feel that I can do so with both justice and authority, because I am the son of a farmer, was born and raised on a farm, made my living on a farm until I was 32 years of age, and during the last six years of that time I engaged in the production and distribution of milk.

Now a farmer's life is not a bed of roses, and what he makes he earns. The labor is strenuous, the hours long, and the obstacles by which he is confronted are many. His every dollar is invested in the acres, stock, and crops he owns and raises, while success to him is limited in a very considerable degree by the uncertainties beyond his control. Consequently, he becomes abnormally intensive in what he thinks and does. And here, I believe, may be found the primary cause for dissatisfaction on his part, as well as for hasty and superficial judgment concerning his business relations with the dealer. He is kept so busy attending to home affairs that he has neither time nor inclination to keep a finger on the pulse of ever-changing conditions, or to assimilate a reasonable knowledge of commercial progress.

All of this is most unfortunate, because it arouses within him a spirit of contention distinctly detrimental to that better understanding which should and must exist if success is to be won.

Our duty, under the circumstances, is to make plain to the farmer that it is to our own material advantage to work for, rather than in opposition to his interests, and that above all things, it is incumbent on both of us to cultivate the broadest possible spirit of co-operation. To accomplish this successfully, he must appreciate the fact that so long as the production and distribution of milk can not successfully be accomplished under one management, the farmer and dealer are an absolute necessity to one another. That done, the rest is easy, because it is to every dealer's distinct advantage that the farmer be suitably rewarded for his product and his toil.

There also are many ways by which the farmer may be relieved of unnatural misapprehension if only he will display a reasonable amount of confidence in working together. Let me explain.

In Milwaukee, for some time now, our company has realized that the cooperative spirit is consistently practical and productive of the very best results. For six months in the year, once each week, from 30 to 50 farmers are taken through our plant and made familiar with every detail in the care and handling of their product. Then, following a hearty luncheon, an hour or so is devoted to a discussion of the farmers' most urgent needs, and we advise with them in such a way as to be of the most practical service. And I could

quote numerous instances in which a saving or gain resulting from these meetings has spelled the difference between a decent profit and a total loss. At first, they couldn't quite fathom the purpose of this open-handed considerateness, and made of it a subject for serious conjecture, and not a little suspicion. But since results have proved favorable to them, there has been a noticeable change in sentiment, and our relations with the farmer have become more intimate and better.

And so from among the hundreds who came in unbelief and to register objections, the majority have gone away satisfied and convinced that there was something worth while in this cooperative idea. And being good fellows, and wise, they have made a closer study of the situation, of the overhead problem, the nonproductive cow, the saving in feed and handling of labor, and are benefiting by it to the fullest extent.

It's a slow process, at best, but so was the modeling of our own free and enlightened Government, and all that it stands for as a humanizing influence among the nations. So we can afford to move with deliberation, that every step may be one of assured progress toward a day of better things.

Looking back over the eventful story of the milk business, the drag of innumerable obstacles, the chill of negative good will, and oppressive influence of unwarranted suspicion, it is pleasant to see that so many among the pioneers in up-to-date milk distribution are still answering to the call of duty as cheerfully and enthusiastically as they did a quarter of a century ago.

And as we review the wonderful progress already accomplished, I am wondering if it would not be wiser for us to forget the vexation of stressful bygone years, and dwell wholly upon our many successes so determinedly and honestly won.

Price is another bone of contention with the producer, due, I believe, to misunderstanding on his part of inflexible sanitary laws, the enforcement of which more than doubles the cost of hauling and distribution. His great obsession, however, is the "spread," most of which he suspects goes to swell the dealer's profit. But increased familiarity with the modern business methods will undoubtedly do much to correct such obvious errors in judgment, and to convince him that dealer's profits, at most, are no greater than his own.

The purchase of supply also has been simplified to a very considerable extent, price now being determined by joint committees of dairymen and dealers. In any event, the question of price, involving as it does such factors as long and short hauls, property values, cost of labor, etc., is of purely local significance, and must be so considered.

Labor, another serious problem to all of us, is largely a matter of environment and must be adjusted accordingly. We do know, however, that much good has already been accomplished in certain directions, as, for instance, by broadening the responsibilities of drivers and making salesmen of them. Not so very long ago, drivers were satisfied to bargain for their services at a stipulated monthly wage, and for many years this apparently was the only feasible plan, although it never did work satisfactorily.

To-day in most of our large cities the driver of yesterday has become a man of influence, working on his own initiative and a percentage basis, that keeps him at the peak in efficiency and earning power as well. It's one of the best things that ever happened for company or man, stimulating each to do their utmost, at all times.

Other problems include ever-recurrent seasonal changes and unusual weather conditions, which interfere with country hauling and delivery—for true efficiency demands promptness in every detail. We also have with us the shortage and surplus problems—not nearly so exasperating as formerly, yet important enough to demand our serious attention, so that they may be handled with as little loss and inconvenience as possible.

Still other factors, such as standardized equipment, uniform accounting, and the zoning of city routes play important rôles in this plan for universal betterment, while the establishment of national laboratories and of a permanent representative at Washington but tend to emphasize the modern milkman's desire to keep faith with his fellow man. This, from close association, I know to be a fact, and that his every motive is based on loyalty to the cause, although, strange as it may seem, there are times when neither the producer nor consumer is willing to accept a statement at his hands, unless incontestible proof accompanies it.

During the strenuous days of the war, when profiteering and the price of milk made choice gossip, for every wagging tongue, distributors became the subject of a tirade of abuse but rarely equaled in the annals of unfairness. And yet, so far as I could discover, his only crime was in working harder and for less pay than ever before. Even Mr. Hoover, just man that we know him to be, became somewhat doubtful, and for a time was inclined to believe it really must be so. He appointed a committee of investigation, of which Dr. Clyde L. King was chairman. Then, with chaos but a step away, the distributors suggested to Mr. Hoover that his committee be instructed to employ some nationally known firm of accountants to thoroughly investigate. This was done, and after making a clean sweep of it in more than 20 of our larger cities, these accountants developed the astonishing fact that while most other foods were selling at two, three, and even four hundred per cent over pre-war prices, the cost of milk to the consumer had advanced only in exact ratio with the increase in prices paid by the dealer to the farmer, and that the dealer's profits, if anything, were even less than before the war began.

That, to me, is but a fair example of the milkman's code of ethics, and among the numerous instances of self-sacrifice made during that most distressing period I can recall none worthier of generous recognition.

Once in a while, of course, some slight acknowledgment may come the dealer's way, yet, whether it does or not, he keeps steadily on his course, subduing obstacles as they arise, doing his best for those he serves, dealing squarely with the world, and striving, by every means at his command, to inspire a spirit of confidence between man and man that will endure forever.

In conclusion, I will say to all milk distributors and producers who conduct their business along ethical lines and produce and distribute only a clean, pure, wholesome milk—the most vital and nourishing food for the masses—that they are performing a most noble service for humanity, a service which, honestly rendered, is certainly a thing to be proud of.

Hanging in the top of the tall tower of Milwaukee's city hall, there is a big bell, on the inside of which there is inscribed a most fitting and worthy sentiment, a silent reminder to our city fathers, the lines of which are as follows:—

When I toll the time of day
From this grand and lofty steeple,
Deem it a reminder pray,
To be honest with the people.

I would like to paraphrase these lines as follows:

When the clocks of the nation strike 1 a. m.
Let that be a reminder pray,
To deliver only pure, clean, wholesome milk,
And thus "be honest with the people."

You will then perform a service to mankind second to none in the world.

Chairman WORK. The next number on our program is, "Methods of buying and selling milk," by Mr. C. G. Morris, president of the New Haven Dairy Co. and of the National Association of Ice Cream Manufacturers. Mr. Morris. [Applause.]

METHODS OF BUYING AND SELLING MILK.

CHARLES G. MORRIS, president of the New Haven Dairy Co. and of the National Association of Ice Cream Manufacturers, New Haven, Conn.

There have been three nominal stages in the methods of buying and selling milk for city markets. While my survey of markets outside of the United States of America has been very limited, the stages in the several markets from which I have had reports have been apparently very similar. The first is where the producer is himself the distributor or dealer who comes in direct contact with the consumer. In the second stage, a higher efficiency is developed by the more or less complete separation of the functions of producer and distributor. In the third stage, the friction produced by this separation is modified by cooperative action.

A survey of the methods used in this country and some foreign countries shows that a similar sequence has been followed in supplying nearly every market. Individual and ingenious local developments frequently appear here and there during the transition stages. Undeveloped markets undoubtedly remain which have not completed the full sequence, and there are other markets where intermediate steps have not been reported. It is possible that in some cases these have omitted the intermediate stages or possibly have passed over them very rapidly. With all these variations, which there is not space enough in this report to list, far less to describe, there still has

been an apparent general sequence of relationships between the producer, the dealer, and the consumer.

Apparently the great majority of the older markets for fluid milk started with the producer retailing his own product. This condition still exists and will probably long continue in the smaller towns and farming districts and is not infrequent as a method of supplying a portion of the needs of even the larger communities. It is quite common in the larger communities to find one or more of these producer-dealers retailing a special grade of milk.

As the community grows, there develops an opportunity for specialization. The type of individual who makes an excellent producer can better afford to confine his attention to his own specialty and furnish his supply to another specialist—a specialist in distribution—rather than to attempt to perform all the complicated operations necessary to produce the supply and distribute it to a city market.

When the relationship of buyer and seller has developed between the city dealer and the milk producer, the first step has been for the dealer to contract with a producer or a group of producers for a supply of milk. This has been a matter of individual negotiation. The dealer offers such price for milk as he thinks will obtain the supply he requires, and the producers who desire to save themselves the labor and worry of retail delivery or of manufacturing butter or other by-products, contract to supply him. The dealer may offer a general or schedule price to all producers alike, or he may make a separate bargain with each one, varying his terms as shrewdly as he is able.

It is safe to say that the ordinary producer thinks of the dealer as the market for fluid milk. Individual farmers' and most farmers' associations have spent their energies trying to get the dealers to pay a higher price for the milk they buy. The dealer knows beyond peradventure that the market for milk is the consumer, and it is only when the consumer is satisfied—in reason—with the price and the quality that there is any such thing as a market for fluid milk. The surplus, also, which can not be sold in fluid form must be made into a product which will appeal to the consumer in competition with like products in the market. In the early stages of supplying a city with fluid milk, therefore, the dealer has had the major part of his attention fixed on the consumer, and as producers have usually been plentiful, the dealer has bid as low as he could to the producer so as to sell as low as possible to the consumer. There have been cases where the dealer even refused to name his price in advance and paid whatever he saw fit after the end of a month or so. In this early period of marketing, the milk was usually bought from the producer in bulk by the canful. If a can held so much as 10 per cent less than its theoretical capacity, the dealer might notice it and protest. A variation of 1 or 2 to 5 per cent might easily pass unchecked. In the very early days, when the doctrine of caveat emptor was universally accepted as proper and watering was not a public offense, a convenient remedy for such discrepancies was always at hand.

Enough of an outline of this early method of selling and purchasing milk has been given to show that it was inevitably unsatisfactory

to all parties concerned. The producer could not fathom the possible fluctuations in the prices he might receive. Though it took months to develop a dairy cow, there might be no wholesale buyer for her milk when she did come in. The dealer, on the other hand, never knew when he was to be short or flush of milk. He rarely got the quantity of milk which he paid for. The system of bulk purchase offered an opportunity for an unearned reward to the producer who was dishonest and tricky. As price was the main selling point advanced by the dealers to consumers, the consumers had no confidence in the dealers' half-hearted claims of quality, and their lack of confidence was all too frequently justified.

The more intelligent dealers did not enjoy doing business on such a hit-or-miss basis and began contracting for longer periods and purchasing by weight—rarely by butterfat test also. This brought

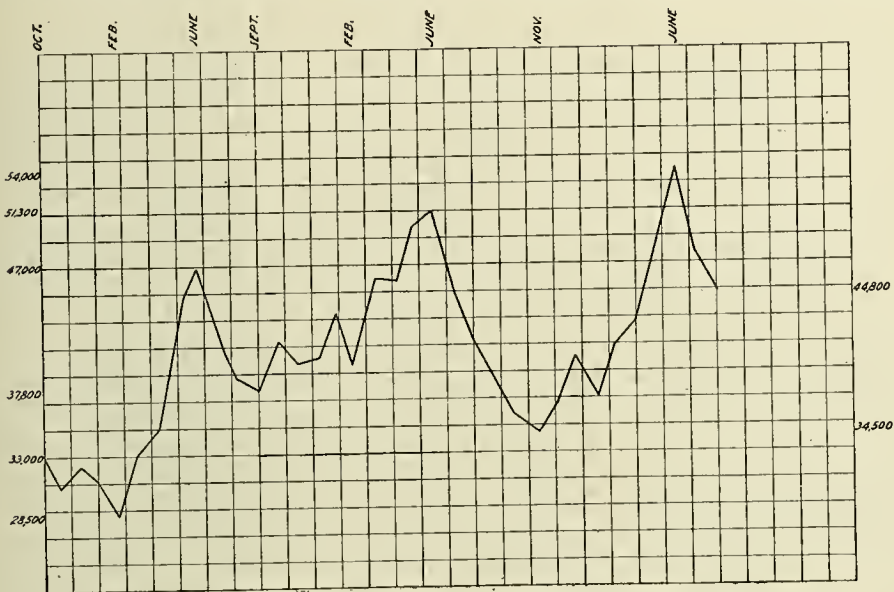


FIG. 1.—Peaks and valleys of milk production at one station.

in the second method in the sequence. And I may interrupt the thought to say that this was evolution, not revolution. Though the various major developments can be recited, their individual variations and modifications are almost as complex and ramified as the development of the human race from animal savagery to the highest type of the modern intellectual.

The second method, in general, consisted of various attempts by the dealers to protect themselves and their customers and at the same time to satisfy the legitimate demands of the producers. Price, of course, is always a debatable and too frequently a sore point. Many devices were used to better this. One method was the publication of prices in advance for three months, or six months, or a year. This, theoretically, gave the producer an opportunity to plan to have his cows come in when the price was highest and to dry them off when the price was low. The dealer, of course, planned to pay the highest price in the short season and the lowest price when he

anticipated that milk would be plentiful. But this gave the dealer's competitor a chance to bid against him. When A had sent out his printed or written prices to a group of producers who were more favorably situated to supply the town than the average, B might offer to pay a tiny percentage over A's known prices to them all or to the most desirable among them, and the producers would leave A in the lurch, often without adequate warning. This was punishment for being intelligent. A permanent betterment was the purchase of bulk milk from the producer by weight. This healed the abuse of short measure. Another betterment was the purchase on a butterfat test. This healed the watering evil, but brought complications in its train which are not yet completely solved. Among the reports I have received, there has been something like 100 per cent variation in the estimated value of a point of butterfat in different parts of this country.

In 1917, evolution gave place temporarily to revolution. The leading buyers among the dealers in the great cities had not realized how the cost of milk production was increasing and that there was no longer in the vicinity of the larger cities any virgin territory from which a fluid milk supply could be drawn in an almost unlimited quantity. They held their bids, therefore, so low, with their most anxious gaze on the consumer instead of the producer, that they drove the producers into organization and then into the milk strike.

As a matter of history, American farmers' organizations have not lasted long. They have all too frequently been conceived in prejudice and ignorance, their business has been carried on under loose management in the face of well-organized or highly competitive conditions, and they have quite consistently failed. But with the recent contact of the buying territories for the several cities greatly reducing, or even preventing, sellers' competition, and with the selection of competent managers for the sellers' organizations, we enter into the third method of buying and selling fluid milk. Prophecy as to whether it will become permanent or not is hopeless. If it proves to be economically sound, if it removes the causes of friction that have been a part of earlier systems, and if it develops no new causes of friction that it can not adjust itself to or eliminate, then it has great elements of permanence. But the element of human whim and forgetfulness of the lessons of the past is also to be reckoned with; the desire of those to whom power is trusted, to abuse it for their own profit and to "play politics" with any organization, still exists. When, or if, these factors become dominant, a new method will again have to be evolved to take the place of those now in operation.

The best of these systems of cooperative milk selling have certain conspicuous features. In order to function they require a producers' organization which has sufficient membership to control a major part of the supply for a given city or group of cities. They require a dealers' organization which has sufficient membership to take a dominant position in the city market. This does not mean that independent producers and dealers must be eliminated. They may be numerous, but they can not long be dominant or they will break down the stabilizing group with their unrestrained competition. The representatives of the producers' organization and the dealers' organization must be able to meet and discuss market conditions from time to time. From an economic standpoint it is entirely immaterial

whether the producers' representatives name the price for the ensuing period and the dealers' representatives have power by common consent to accept it or reject it, or whether the process is reversed. In either case, it is simply collective bargaining. From a legal standpoint, however, it may be very important which organization names the price, as farmers' organizations are frequently granted legal immunities that are denied to other business organizations. In either case, the price developed by such a conference has eliminated so far as possible the elements of whim and guesswork and is based on a bona fide report of actual market conditions.

The next element in these recent systems of cooperative milk selling is usually the division of the supply into a basic quantity which is to be sold as fluid milk and which is paid for at the highest price,

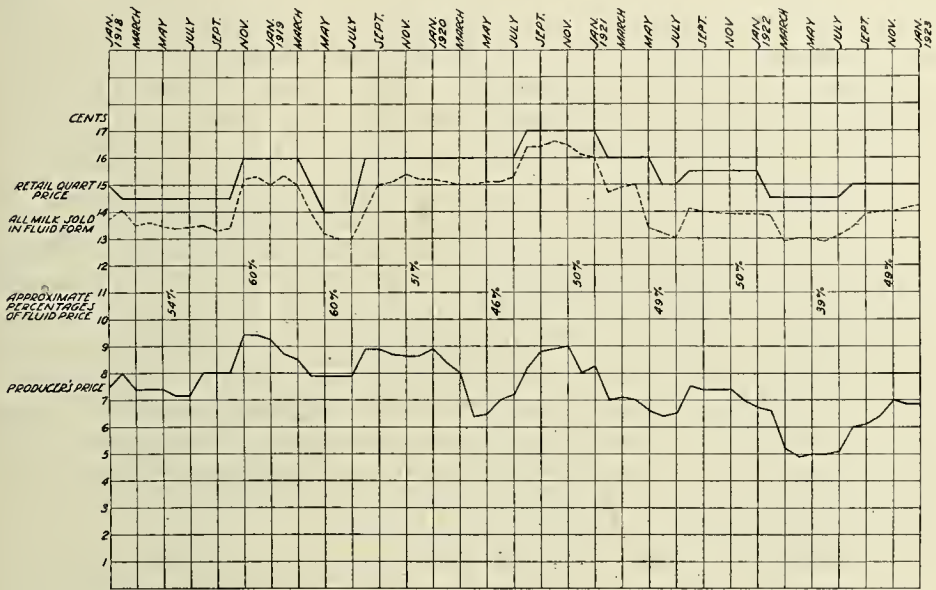


FIG. 2.—Spread between price paid to producer and price received by dealer for all milk sold in fluid form, and the percentage which the producer received of the amount received by dealer.

and then a classification of the remainder based on its value when converted into other milk products such as butter, cheese, condensed milk, casein, etc. One of the most conspicuous points of friction between the producers and the dealers in the past has been the question of surplus and shortage. It has been made a further point of friction between the dealer and the consumer by sensational articles in the daily press which have been conspicuously misconceived and perverted from the whole truth.

In the past, surplus has been the *bête noir* of every milk dealer. The ignorant producers and the ignorant consumers have both been led to believe that the dealer who sells 1,000 quarts of retail milk a day at 15 cents a quart and buys milk from the producers at 8 cents a quart, has a working margin of at least 7,000 cents a day. From this, they realize that, of course, he takes delivery charges, rent, and "a few little things like that" and pockets a net profit which they assume to be from 2 cents to 5 cents a quart a day. I

have asked scores of otherwise intelligent individuals to name the net profit they assumed the milk dealer makes and have never found one who named less than 1 cent. But when the dealer has disposed of a surplus supply of fluid milk which has run from 5 per cent (which is a very narrow margin) to 100 per cent (which has not been unknown in the flush season) in by-products, his working margin after obtaining the 1,000 quarts mentioned above for retail sales will not be anything like 7,000 cents. It may be nearer 5,000 cents. Figure 2 is a record of sales showing what has actually been, in at least one company's experience, the working margin or spread.

From this working margin or spread must be paid not only the upkeep of some three delivery outfits for each 1,000 retail quarts delivered, with their drivers, but the power plant costs and upkeep, together with a skilled creamery operator to convert the surplus fluid milk into by-products. If the surplus was steady this should be a profitable operation, but if there is only a trifle of surplus for some months at a time and then an enormous surplus at other times, this operation can not be highly efficient. It is safe to say that in city plants it is always performed at a loss. It is one of the inevitable losses which are just as much a part of the business as depreciation on machinery and can no more be avoided than that can. This is only one item of many the dealer must adjust for and carry, out of his working margin or "spread." Its importance and the usual public misconception concerning it justify what has been more than a mere passing reference to it in this article. It interested me, during the several expensive public investigations of the milk business, made during the war and heralded with a great flourish of newspaper headlines, to watch some time later for the outcome. This would be printed in small type on an inside page, and quite uniformly showed that other dealers had a very similar fraction of a cent net profit to that my own books showed.

The conference body between producers and dealers, therefore, at the present time usually classifies the surplus according to its disposal on the market or markets the conference covers. Various methods have been attempted in the past to care for this surplus. An early method was for the dealer to contract for the exact quantity he required, with the assumption that the rest would remain on the farm to feed calves, pigs, etc. But few farmers, near a city market, can refrain from taking their fluid surplus into town and selling it for what they can get. If the surplus were permanent, this would be proper, but a group of farmers may all dump their surplus into the same market on the same day, or perhaps every day for a week, and then have no more to sell. They are almost sure to break the market for their whole supply permanently, however, in such an attempt to dispose of this fraction. The later conference committees, therefore, have provided that the dealer shall take all of the milk that each producer who supplies him at all shall have for sale. Then the dealer pays the highest price for a given quantity sold (or in some cases assumed to be sold) as fluid milk. For the balance he pays a price based on its value in by-products.

The pooling system has been a natural development of the organization of producers. It always caused bitterness when one pro-

ducer sold to a city milk dealer who paid fluid value for his milk based on the restricted competition which had developed in a local market only, while the producer next door had no choice but to sell an equal grade of milk to a condensery or a butter factory which paid a price based on the competition in the world markets for such products. It was not the fault of the buyers that there was a wide difference in the prices, but that fact did not lessen the disappointment of the producers. Under the pooling system, all the milk produced by the members of the association is paid for alike. Such proportion of the total as is sold as fluid milk brings the highest price into the pool, and such part as is sold for making by-products brings its lesser value into the pool. The whole is then divided pro rata in proportion to each producer's total production.

Some of the producers' organizations have developed more or less successful methods of stabilizing their supply. Conspicuous among these is the Connecticut Milk Producers' Association plan of holding their members to an exact stipulated production and fining those who exceed their contract or who fail to produce so much as they have agreed to. This fine is deducted from the pay check of the negligent producer and added to the pool from which all are paid, for the benefit of his more efficient fellow-producer.

Other systems of cooperative milk selling from producers' organizations have had some vogue, but the pooling plan, where properly managed, has a great deal to be said for it. It does offer opportunities for ambitious and selfish organizers or officers of the associations to enrich themselves unduly at the producers' expense. But if all desirable improvements in human relations which have been seized on by the unscrupulous for self-aggrandizement or illegal profit are to be discarded because of that defect, nearly every organization, from the churches and popular government to mutual life insurance, would have to go. The best protection is a policy of open bookkeeping and an opportunity for full and free investigation by any person who questions the actions of the organization to which he belongs. Where this is denied, it is probable that the familiar history of other farmers' cooperative movements will be repeated, with their inevitable succession of high and unjustified hope, fraud, disillusionment, failure, and despair.

In certain locations the contracts provide that a fixed percentage should be deducted from the producers' checks by the dealer, matched with a like amount from his own funds, and used by some dairy and food council or similar organization for public educational work as to the food value of milk.

In addition to these outstanding features of the more recent milk contracts are provisions for insuring proper sanitary quality for the milk; setting the period during which the contract is effective; fixing the methods of payment; providing for audit of the dealer's books on behalf of the producers, and the deduction of the several producers' dues to their association. This last is the famous—or infamous—"check-off" system which has proven a source of endless trouble in other industries and is quite certain to become the same in this industry. It has, however, certain very obvious conveniences which have secured its general introduction into cooperative milk contracts.

There are several charts appended, showing the course of milk prices in several markets. It is characteristic of them all that the producer received a larger percentage of the price paid by the consumer during the war period than before. Our own charts show

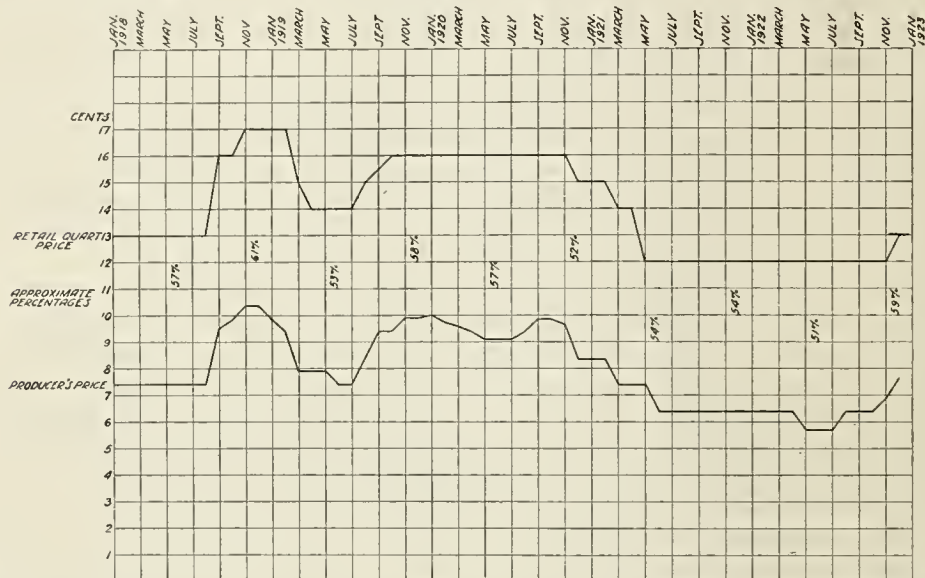


FIG. 3.—Spread between price paid to producer and that received by dealer as retail quart price, and the percentage which the former is of the latter, in a different market from that represented in Figure 2.

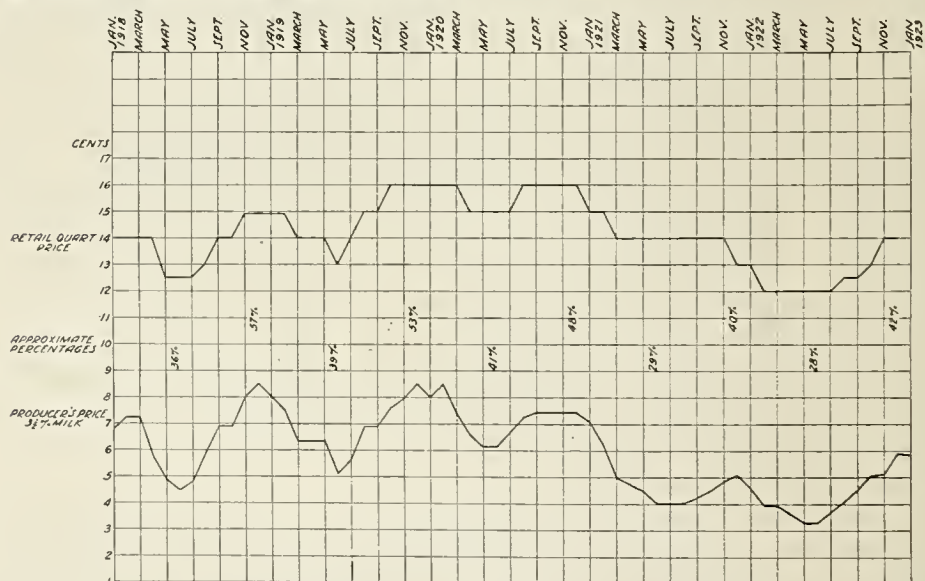


FIG. 4.—Spread in a third market between price paid to producer and price received by dealer, with percentage which the former is of the latter.

that there has been a curious stability in the percentage which the producer received, of the total actual sale price of fluid milk. In my estimation this is because the item of labor is so large a part of the cost of producing and delivering milk that both producer and dealer are tied close to the fluctuations of the labor market.

Chairman WORK. The next subject is "Work of the National Dairy Council in bringing about a greater use of milk," which will be presented by Mr. M. O. Maughan, of the National Dairy Council. [Applause.]

WORK OF THE NATIONAL DAIRY COUNCIL IN BRINGING ABOUT A GREATER USE OF MILK.

M. O. MAUGHAN, secretary, National Dairy Council, Chicago, Ill.

Mr. Chairman and fellow workers: I call you fellow workers because I take it that we are all engaged in the same line of business.

As you all are possibly aware, the National Dairy Council is organized for the purpose of educating the American public to a greater use of milk, butter, ice cream, cheese, and other dairy products.

We decided we could best tell the story of dairy products by presenting to the American public the broad health program based on the standard eight rules of health in which milk and dairy products play an important part. We feel that the story of the wonderful value of dairy products will be received more enthusiastically by the public if we present it not alone, but along with other important things, all of which are essential to the health and well-being of the American Nation. We are doing our best to get this message across.

We have been very fortunate indeed in getting unusually good cooperation from the various health agencies and organizations throughout the country at large, including the United States Government, various colleges and universities, and the various national and local health and civic organizations interested in promoting health and child welfare. We have also been very fortunate in getting the support, both financial and moral, of those engaged in the production, manufacture, and distribution of the products of this great industry. They have financially cooperated with us in a most splendid way.

In glancing at the map of the United States it is to be noted that there are council organizations now in 15 different territories, comprising 21 different States. Others will be organized as time goes on and as the milk producers and milk dealers and other dairy interests, as well as the consuming public, become ready for council work. In territories where dairy council work is being done it is interesting to note that there is very little misunderstanding between producer and distributor because each is thinking in terms of an industry rather than in terms of individual units.

During the past two years the consumption of milk in the United States has increased 16 per cent per capita. During the same period the consumption of butter has increased 11 per cent per capita. We believe that the National Dairy Council has been one of the main and principal organizations in bringing this about.

Milk consumption in the Philadelphia territory increased 14 per cent during the first year of council work and 12 per cent during the second year. Unusually intensive work was done in this territory.

In Pittsburgh milk consumption increased 11 per cent during their first year, while a survey of conditions in St. Louis shows that milk

consumption increased approximately 19 per cent during the first year of work.

In one valley in Ohio, where there are four towns all with the same type of people and the same type of industries, it was found that where we conducted educational work the consumption of milk increased 13 per cent, while in the other three towns where none of our work was conducted the increase in milk consumption amounted to only 3 per cent in each town.

The dairy councils are now recognized as standard health organizations and are being called upon by hundreds of organizations for support from time to time.

The National Dairy Council has been very active in securing the enactment and enforcement of various legislative measures, all of which are of great value to the development of this industry in this country.

Another activity of the dairy councils has been the establishment of the daily milk service in the schools, with most wonderful results. Practically all the school authorities who have tried out this measure are so enthusiastic about it that they are establishing it as a permanent health measure in their schools.

It is interesting to note how remarkable has been the decrease of undernourishment among children in the territories where council work has been and is being conducted. Various statistics were given out in this country about five years ago to the effect that there are all the way from 20 to 33½ per cent of the boys and girls undernourished. We found in territories where our work has been conducted for two or three years that the amount of undernourishment has been reduced to a very low figure as a result of our broad eight-rule health program which is followed.

We have refrained from advertising in the newspapers and in national magazines to any great extent, believing that if we would first of all get cooperation from the schools and women's clubs and the editorial departments of the newspapers, making our program a civic and national educational measure, we would get much further than by following the ordinary well-established commercial measures to increase the consumption of an ordinary product. Some of the people who have been watching our work in this country have not found very much spectacular publicity on the part of the council. Our work has been more or less subtle or submerged because of our broad eight-rule health program and because we have worked with the schools, believing that the strength of the Nation to-morrow depends upon the health of the boys and girls of to-day.

There is now a total of 102 workers in this country engaged in dairy-council work. In Philadelphia we have 32 workers who are busy all the time going into the schools and other centers putting on health programs and health plays, telling health stories, getting the children to develop milk and health posters, getting them to "chase the coffee pot out of the room," and all become milk drinkers themselves, and so on.

In Pittsburgh there are 16 workers working along the same general lines as the Philadelphia Interstate Dairy Council and the other councils.

In California there are 8 workers, and so on, making the total of 102, as mentioned.

The council believes that along with the work of educating the public must be work among the milk producers to improve the quality of milk. We believe this quality work is one of the most important activities of the council, therefore, we go to the farmers and persuade them of the necessity of producing clean and wholesome milk.

In the Pittsburgh territory, as a result of three or four months' campaign among farmers, the score of the milk has been increased from around 60 to 92, and the public has not been at all slow in recognizing an improvement.

I believe, gentlemen, that the dairy industry must not only educate the public to use more milk, but must also educate the farmer to produce cleaner and more wholesome milk, because educational work to the public will not be very effective if the quality of milk is below standard and is not absolutely safe for human consumption.

It appears to me that in order for the dealers to sell a better quality of milk in this country emphasis must be laid on the production end of this industry, because the milk dealer is now doing about all he can to turn out good milk under present production methods. Nearly all of our progressive dealers now Pasteurize and follow other important and necessary measures. After milk is received by the dealer it is handled quite scientifically in most cases until it reaches the housewife.

The National Dairy Council is at the service of the dairy industry. We want every one engaged in dairying to stand back of the council and become not only a passive supporter but an active supporter and tell us how the work can best be done. The more conferences we get into with all our heads together working along a definite line that eventually will put this industry where it belongs, the better off we will be.

I have often said that the dairy industry has everything in its favor but public opinion. The industry has the support of doctors, generally speaking, of nurses and scientists, the United States Government, and other powerful forces, and they are all saying that "Milk is the best food there is," and that the American public should be using nearly twice as much as they now consume. As yet, however, the public has not become fully converted to these statements. It is the work of the dairy council, with the help of the entire dairy industry, to show the public the importance of milk in promoting the health and well-being of the American public.

Chairman WORK. We will next take up the subject, "Some problems of milk distribution," by Mr. Ben Davies, of the United Dairies, Ltd., England. Mr. Davies is not present, but Mr. Price of that company will read his paper. Mr. Price. [Applause.]

(Mr. Price read Mr. Davies's prepared paper.)

SOME PROBLEMS OF MILK DISTRIBUTION.

BEN DAVIES, United Dairies Ltd., London, England.

The problems of milk distribution which can be helpfully considered by an international congress are those which relate to the elementary and fundamental principles and duties connected with the service which distributors have to perform. Many of the problems which daily confront them and which loom large on the day's horizon are local and temporary and are dependent on the domestic habits and national characteristics of a people. The problems are further affected by the nature of the milk supply, the length of the haul from farm to city, as well as by the facilities for transport; by climatic variations, by availability of natural ice, and to no small extent by the per capita consumption of milk.

According to the scale of his operations, the distributor has to deal with the produce of hundreds of farms, of thousands of cows, and vast numbers of individuals have to contribute their moiety of service in milking and attending the cows, in washing the various utensils, in refrigerating and transporting the milk. Ill health among these individuals or among their families may pervert the healthful properties of this precious food. Carelessness, uncleanness, or deliberate dishonesty may deteriorate its quality. These are problems which demand infinitely more of the distributor than un-sleeping vigilance. His guaranty of the healthful purity of the milk supply must be independent of the health, efficiency, and even the honesty of those thousands of elements which are included in the organization of our daily milk.

To assure adequate supplies of milk at all seasons to a large city is a matter of great complexity. The production of milk is not to be expanded overnight to meet extra requirements. Extremes of temperature increase the demand enormously, but, almost in inverse ratio, at the same time nature restricts the supply. The flush of production is in spring, the flush demand is in midsummer or winter. Therefore the lowest valley of supply must overtop the highest crest of demand. That there shall always be enough, there must at times be a great deal too much, and this surplus has to be converted into various manufactures involving great sums of capital and no small enterprise.

Again, to appreciate the problem let it be remembered that the distributor sells not merely milk, but milk plus service. And a degree of service which costs even more than the milk itself. It means milk delivery at awkward and inconvenient hours. It means an auxiliary system of local stores where extra supplies may be easily procured at any time. It means a credit department where myriads of small accounts are recorded and the payments of which are made at intervals largely dictated by the consumer. It means the maintenance of laboratories and workshops, of experts and supervisors, to an extent unparalleled in any other food service.

And all this service, together with much more that has not yet been detailed, has to be performed at a price which is enormously less than the charge for the mere transport of an individual parcel of corresponding weight by the post office, or by any express or railway company. Assume that the average letter weighs one-fifth of

an ounce, and the postage is 3 cents per letter, as is still the case in England, then the post office receives 10 shillings, or, say, \$2.50, per pound weight of letters transported. Or even taking the parcel post rates for comparison, the charge for the mere transport of a weight equal to a pint bottle of milk would be 18 cents, as against the 6 cents received by the distributor for transport, service, and milk.

Did space allow, it would be interesting to show the extent of the distributor's transport over and above the net weight of milk actually dealt with, but this would carry us too far. The figures, however, are stupendous, as can be gathered from the mere statement that United Dairies (Ltd.), in London alone, deals with 1,000 net tons of milk a day, and delivers direct to some 400,000 households every day, in most cases twice a day, and that its wholesale transport by power trucks alone exceeds in annual mileage a hundred times the circumference of the earth.

It is forgetfulness of this element of costly service which accounts for much of the criticism as to the extent of the difference between the price paid by the consumer and that received by the producer. Considered by itself, milk is sold as cheaply as ever. The ever-growing need and demand for more and new forms of service accounts for increased prices and costs. The prospect is that the demand for service will increase rather than diminish. One of the distributor's great problems is how to meet all such legitimate demands, how to give more and better service, and yet restrict his selling price.

But is all this service worth its cost? Could not some of it be dispensed with? Could not business be more economically organized, as regards credits and collections, accountancy, distribution, etc.? Before dealing with such considerations in detail it is well to consider them broadly and from various points of view. Freedom is a priceless boon which like other blessings we rarely appreciate until it is lost.

'Tis sweeter to bleed for an age at its shrine,
Than to sleep for a moment in chains.

In England during the great war we fretted and fumed under the restrictions, controls, and orders which were then inevitable in order to apportion the restricted food supply. So long as that is remembered, no one will willingly accept any scheme of organization which compulsorily limits the choice and method of one's service. Complaints were rife of incivility, of friction, and of indifference of sales people. With normal freedom all such complaints disappeared. Freedom is better and cheaper than any arbitrary control, no matter how benevolent its despotism may be in intention, nor how perfect as an economic theory.

If the service offered is too elaborate and too costly, there is always room for a courageous and enterprising competitor to prove it by offering a cheaper service. Let it be remembered that every practical advance in the milk industry, and every refinement of service, has been made by business men dealing with difficulties as they were experienced or discovered. It is true that Pasteurization on its initiation was an economic proposition. Its scientific justification

was discovered after its value had been proved by practical experience. Refrigeration was the same. As I have ventured to suggest in another paper, the scientific reason for bottling milk has not been fully and generally appreciated even yet. Such operations are not, therefore, theoretical fads to be cast aside as some other ephemeral fashion flits into view. They are not mere stunt advertising schemes. They are services which have been adopted at the stern dictates of experience, and which have been modified or developed after going through the testing fires of the same hard school.

It is more than strange, with so much attention focused on milk, with so many researches in progress, that milk has so seldom been followed from the cow barn to the home. Yet, in spite of this, evidence has accumulated which shows that efforts have been misdirected and are therefore inefficient in stopping the waste of infant life. These and many similar problems seem to wait for intelligent and combined study by the industry, so that we may know where we have to guard, and may also learn to draw true inferences from the facts of experience.

How far the dangers to milk are due to the farm, to the dairy, or to the home; the relative importance of Pasteurization and of insulation by delivery in glass bottles as means of promoting infant welfare and public health; the bearing of vital statistics on the industry; the comparative nutritional value of dried milk and fresh fluid milk; all these, and many more such questions which to-day are largely the subject of personal prejudice, demand the combined study of the industry as a whole in order that it may be established on a basis of true knowledge and worthy service. It is doubtful whether any investment in knowledge and research in other fields will yield such rich reward in human happiness and in the progress of the race.

Chairman WORK. The next paper will be "Economic and social factors in price conciliation in the milk industry," by Dr. C. L. King, secretary of the Commonwealth of Pennsylvania. Doctor King is not present, but Mr. Frank P. Willits will read his paper. Is Mr. Willits in the room? It has been suggested that some one look for Mr. Willits so we can have Doctor King's paper read. Will you look for Mr. Willits, Mr. Kelly?

That seems to conclude the papers that are here to be presented to-day, and we can now open up the meeting to the discussion of those papers which have been read. I think the value of these papers is brought out very materially in the discussion of these subjects.

Now is there any discussion on the papers that have been presented?

Mr. CHAS. H. SNOW (Snow & Palmer, Bloomington, Ill.): I would like to ask Mr. Le Feber a question. I wish he would please state their method of arrangement in putting on new wagons. How do you compensate the drivers for territory removed from routes already in operation when you put on additional wagons?

Mr. LE FEBER. A new driver that is added to our force is put on a guaranteed salary of \$135, and he may only earn on a commission basis \$75 or \$100.

Mr. SNOW. As you remove territory from the other drivers are they in some other way compensated?

Mr. LE FEBER. If their commission should go below \$135 they get the \$135 any way.

Mr. MORRIS. You give them no bonus for the milk you take from them?

Mr. LE FEBER. We usually pay them a salary the same as they have been earning for a period of two months.

Mr. MORRIS. That carries them forward on their old basis?

Mr. LE FEBER. Yes.

Mr. SNOW. That is compensation for what you removed from them in a certain sense?

Mr. LE FEBER. Yes.

Chairman WORK. Is there anyone else who has a question to ask?

Has Mr. Willits been found? If not, our secretary, Mr. J. W. Bartlett, dairy husbandman, State of New Jersey Agricultural Experiment Station, will read Doctor King's paper for us.

(Secretary Bartlett read Doctor King's prepared paper.)

ECONOMIC AND SOCIAL FACTORS IN PRICE CONCILIATION IN THE MILK INDUSTRY.

CLYDE L. KING, A. M., Ph. D., secretary of the Commonwealth of Pennsylvania, Harrisburg, Pa.

In the last 30 years there has been a marked increase in industrial conciliation. Many now are the contracts between industries, on the one hand, and organized laborers, on the other, by which each party agrees to submit conflicts to arbitration when the two parties immediately concerned can not themselves come to a friendly understanding. Many such contracts now provide the machinery for arbitration at any time. Thus in the men's clothing industry practically all the large manufacturing establishments have labor agreements under which questions as to hours, wages, and working conditions are referred to an arbitrator chosen by agreement and paid equally by both sides. The decisions of this arbitrator are final during the period of the contract. Among business men themselves the principle of arbitration is widely applied. Various trade associations such as the lumber trades, the National Association of Manufacturers, and the Silk Association of America provide arbitration for their members. The American Bar Association, by resolution adopted in August of 1922, indorsed the draft of a Federal law making arbitration awards enforceable.¹

Contracts accepting the decision of an arbiter have recently been adopted in large numbers by business men engaged in international trade. The arbitration machinery set up by the Chamber of Commerce for the State of New York has been used by exporters and importers for over 100 years. Since 1916 traders between the United States and the Argentine have used arbitration machinery set up by the joint action of the Chamber of Commerce of the United States and the Chamber of Commerce of Buenos Aires. The In-

¹ See *Annals of the American Academy of Political and Social Science*, Vol. CVIII, No. 197, p. 91.

ternational Chamber of Commerce has recently prepared a comprehensive scheme through which the merchants of all countries having business organizations affiliated with that organization can have available arbiters whose decision will be rendered at relatively little cost and inconvenience. Business men are putting less business into litigation by setting up a method for securing prompt and informed decisions on differences.

Of recent years conditions have arisen in the milk industry similar to those in other industries, which make conciliation and arbitration both advisable and effective. It is the purpose of this paper to discuss as briefly as possible some of the economic and social forces affecting price conciliation in the milk industry.

WHY PRODUCERS ORGANIZE.

The first of these forces accounts for the reason why milk producers themselves are so universally self-organized into selling associations.

The time was—and not so far distant—when the morning churn offered the farmer as fair a market as any for his milk. With the perfection of the cream separator and cold storage came the cross-roads creamery, usually at the instigation of those with machinery to sell, usually under cooperative auspices—and usually failures.

The savings in cost of operation due to volume, the better talent made possible by larger plants, including marketing specialization, brought the large butter centralizers, each with its own large receiving station. A similar change in manufacturing, marketing and storage facilities, centralized the purchases by manufacturers of cheese, condensed milk, and other milk products. These, too, came to purchase their milk from the farmer through large milk receiving stations.

When our urban population was small the near-by farmer could profitably sell his milk direct to the consumer. But the producer-distributor was often careless of the rights of his customers to a good product. City ordinances were therefore passed intended to provide for a minimum butterfat content and to prevent adulteration. The development of medical science brought Pasteurization, with its additional cost and specialty, as insurance against milk-borne disease. In the meantime the dairy farms were pushed farther and farther from the growing cities. Urban milk distribution became a special business and the producer-distributor gave way to the professional milk distributor. With increasing volume came decreasing unit costs and hence increasing volume by the larger distributors. These distributors had to reach out farther and farther into the country for their milk supply. Their economical country unit, too, came to be the large receiving station.

Soon it came to pass that producers had but one station at which most of them could sell, whether they were selling to manufacturers or to city milk distributors. Confronted with a single buyer the producers banded together into single selling agencies. And hence in this country collective bargaining became the rule.

But these unions of milk producers soon found that their union was not protective in fair prices unless practically all producers were

included in the union. Milk dealers offered attractive prices when milk was scarce, to producers who could ship direct, only to pay much lower prices when milk was plentiful. The lower prices when the market was plentiful led to competition in the cities, particularly for the store trade, and soon the prices to all producers had to be reduced. Opposition to price increase by consumers made it difficult for producers to get a fair price later when milk was not plentiful, and when producing costs were higher.

Hence steps had to be taken to get all the dealers to recognize the cooperative selling agency, on the one hand, and to get all producers to sell through this single agency, on the other. Milk dealers preferred a set price, as competition could and did proceed more orderly, and more effectively, within the city when the price for milk was the same to all, for the milk dealer was interested in good will and the larger net profits due to volume just because the profit per quart was smaller, as will be discussed more fully later.

There was present another economic force that brought collective selling agencies to producers. This was the importance of the monthly milk check to the average milk producer. In milk production the marginal production that tends to set the price, particularly in seasons of heavy output, comes from that small herd that will consume all the roughage produced on the farm, with the family doing the milking and other dairy work. The monthly check from such herds is not large, but it is all important. Every dollar counts. And farmers know that dollars brought home by good marketing buy just as much as dollars made by long hours of hard work.

Then there were social factors at stake. "If you don't like our prices, why do you produce milk?" the producers have been asked often enough by milk purchasers everywhere. The answer has just as much to do with milk prices as do production costs. The answer is: "We have here our homes, and our schools, and our churches, and our friends. Diversified farming is more to our long-time interests. And we want to stay in our own business in our own homes, in our own communities. We believe you can pay us more, and we want every cent you can profitably pay us." The milk industry, like any other industry, is a complex of old habits and old friends with new prices and new methods.

And so the producers organized to sell as one man to the one purchaser in their territory. Social factors are just as important in price determination as are purely economic factors.

With the concentration of manufacturing and whole-milk distribution, it became more difficult for the producer to judge what a fair price was. The big milk buyer rides in a big car and looks more prosperous than the farmer. Hence it is easy to conclude that big milk dealers are making an unfair profit when compared with the small net profit the farmer makes. And that many a milk buyer did take advantage of the milk producer before producer unions were organized there can be not the slightest doubt whatsoever. Nor is there any doubt that milk buyers will now take advantage of milk producers should producers' selling agencies be dissolved.

There were and are advantages in large selling organizations of milk producers other than the assurance of a fair price. One of

these advantages is the assurance of a steady market. Particularly in direct sales of whole milk there are frequent changes in milk patrons, as each buyer makes the most of his market opportunities afforded by buying from many unorganized individual producers. When farmers sell through one agency at the same price to all, there is a steadiness of market worth in itself quite a good bit to the producer.

Then again such selling organizations can, at little individual cost, provide for independent tests of butterfat, thus giving the producer a confidence in his market he could not otherwise secure. Other similar services such organizations perform are improving shipping facilities, checking up losses at stations by petty thefts, and an informational service as to cattle diseases, cooling of milk, etc.

These economic and social forces that have universally brought milk-selling organizations into existence have proved also to be persistent and powerful enough to keep such organizations intact.

ADVANTAGES OF COLLECTIVE BARGAINING TO MILK PURCHASERS.

Nor do the advantages of such organizations accrue only to the producers. Milk purchasers find advantages in them also. Milk purchasers in any large territory have many things in common. They must meet similar legislation, proposed or actual. They have common troubles in getting milk that is clean, unadulterated, and properly cooled. They have common interests in wages and commissions to salesmen and to wagon drivers. They will usually have common difficulties as to transportation and refrigeration. Hence they tend to get together.

But this is not to say there is no competition among them. In whole-milk distribution there is the keenest competition, as all who know city milk markets intimately will testify. This competition is not always in price in the retail trade, to be sure. But even in the retail trade such competition in the form of service and quality is keen. The plane of competition is now raised, as a rule, above such former methods as putting dirt or even manure in the other fellow's milk. But competition is there nevertheless. And in the bulk and wholesale trade competition is usually very keen.

Competitors compete only because and when competition pays. In whole-milk distribution competition pays when it adds volume. For, other factors being equal, the greater the volume the less the unit cost. Competition also pays the milk distributor who gets thereby a larger load for a shorter haul. Competition pays when it builds up good will with consumers. And good will is the best business asset of the large distributor. Thus it may pay the small milk dealer or the small producer-distributor to water his milk if he can readily move into other districts and get new customers. But such practices by the larger distributors, especially when they bring adverse newspaper publicity, cost infinitely more than they are worth. The responsible milk distributor wants good milk, and this he gets most surely through a wholesome quality of milk in steady supply, and these he gets most certainly through a producers' selling agency.

Moreover, as soon as a milk purchaser owns several receiving stations, his producers at all his stations demand the same price. To

pay the same price at all stations the large purchaser wants other near-by purchasers to pay the same price. The purpose back of this may be, and no doubt often is, to have all pay a lower price to the producer. But in most instances the value of uniformity in known prices and the necessity of a steady supply are sufficient to make the large milk purchasers have a common interest in a fair price as well as in a common price to milk producers. Good will in the country is as valuable as good will in the city. And identity of price tends to eliminate ill will, while making it possible, through prompt payments, good service, and fair tests, to develop a good will which brings its return in a better quality of milk and in a supply to meet the peculiar needs of the purchaser.

The margin of profit per pound of manufactured goods or per quart of whole milk is small. In whole-milk distribution it is seldom that the net profit averages over half a cent a quart for any considerable period. Hence, under similar prices to farmers, the price delivered to the consumer must be uniform. Competition takes the form of service and quality.

Economic forces, therefore, tend to make collective bargaining on the whole advantageous to large, responsible milk buyers.

COLLECTIVE BARGAINING AND THE CONSUMER.

The city consumer's need is for a constant supply of wholesome milk. The fact that milk is the food for infants and for the sick makes the price of whole milk always of public interest. All milk stories make good news. Publicity is the weapon always at the consumer's hand to combat unfair whole-milk prices. And manufactured milk products are always in keen competition with other foods. The consumer chooses what he eats. And, while habit plays its part in food purchasing, there is invariably wise purchasing in amounts sufficient to give fair price protection to the consumer.

This price protection is all the more effective because of the fluidity of the world's milk market. Milk knows no boundaries and flows to the highest price wherever ships sail and trucks and trains move to market. A local shortage of milk brings by telegram cream for the restaurants and for the manufacture of ice cream from the nearest territory where the milk is plentiful. Ice-cream manufacturers are no longer dependent on local milk supply anywhere. Sweet butter from Wisconsin and condensed skim milk from Seattle with a plentiful addition of local water, will make a good ice cream whether in Oshkosh, Timbuctoo, or the Holy Land. A variation for but a few months of as much as half a cent a quart will pull milk from Philadelphia milk territory to Baltimore or from New York territory to Boston. Many an eastern breakfast table has been served whole milk from Wisconsin, and many a breakfast table has been served, when local milk was scarce, with a product locally made from milk powder from Minnesota, butter from Kansas, and water from the local well. Any changes up or down in milk prices to farmers in one territory are soon felt in near-by territories. The consumer's protection lies in the fluidity of the milk market. Tariff walls themselves do not suffice to keep out for long the milk that is ever restlessly in search of its best buyer.

To the milk consumer, service is of importance second only to price and quality, and it is this very service that the large dealer wants to give in order to expand his plant volume, increase his loads, and shorten his hauls.

The great opportunity of price conciliation lies in bringing to a common point the interests alike of producers, distributors, and consumers. The steady market the producer needs is found only through the wholesome milk and wholesome milk products which the consumer desires. The price of milk at the farm gate is the price on the consumer's table less the cost of getting it there. The distributor wants volume, and volume comes only through distributing costs as low as are consistent with good service and good quality. The interests of these three can be harmonized. They have interests that are different, to be sure, but their differences are not so numerous or so important as their common needs. Through (1) educational work in the city as to the food value of milk, (2) through cooperation among producers to get a product worthy of wider public consumption, and (3) through the help of middlemen to keep down their costs, both as insurance for stability and to meet public needs, a market can be developed with sound competition and fair prices to consumers. Such ideals are now finding expression through dairy-council work.

Milk, the food most easily contaminated, can and does reach the consumer's table in better condition, in season and out, than any other food. Milk, the most perishable of products, can be and is being brought daily to the consumers direct from the farm at a middleman's cost below that of any other food product. Such a market is of importance to everybody.

Such are some of the forces that bring the demand for the machinery of price arbitration. The arbiter does not work alone. He has as his aids the most powerful forces of modern industrial life. Let us briefly pass some of these forces in review.

(1) The trend toward monopoly at the local receiving station.

(2) The need of selling organizations of producers to assure a fair price.

(3) A strong organization of producers with real power to refuse to sell.

(4) A strong organization of milk purchasers with effective power to refuse to buy.

(5) The importance of the milk check to the farmer, however small that check may be.

(6) Specialized knowledge as to the ability of the milk purchaser to pay.

(7) The final choice as to what shall be bought to eat is made by the consumer.

(8) The price of milk and its products is always a good news story.

(9) Good will is the best asset of the large milk purchaser, and a steady market one of the best assets of the milk producer.

(10) Service uninterrupted is of vital importance, second only to price, to the city whole-milk consumer.

(11) A fluid market which quickly corrects errors of judgment.

(12) Specialization by producers and by distributors, each performing his own service to the best interest of the other.

(13) A competition for volume that tends to assure a fair price to consumers.

(14) And last, but not least, an opportunity for bringing the life interests of producers, distributors, and consumers alike into fair economic harmony.

With 14 such aids, is it any wonder that price conciliation and arbitration in the milk industry succeeds as it has and as it does in other industries? It is not the opinion or the knowledge or the decision of the arbitrator that counts. He is successful only as these economic and social forces find a normal and fair avenue of expression through him.

The law of supply and demand is no Juggernaut car before which any economic class need cast themselves. Both supply and demand are the resultant of numerous forces, all of which can be analyzed and understood, and through understanding made of human advantage when expressed in price.

(Adjournment.)

(Papers read by title):

LA PRODUCTION ET LE COMMERCE DU LAIT DE LA RÉGION LYONNAISE.

R. GUYOT-SIONNEST, Secrétariat Central du Lait, Lyon, France.

L'agglomération lyonnaise comprend 700,000 habitants qui consomment une moyenne journalière de 120,000 litres de lait en hiver et de 90,000 à 100,000 en été, soit une réduction d'un sixième environ au moment de la belle saison, celle où la production est plus élevée (un cinquième à un quart en plus qu'en décembre et janvier). En hiver, il y a sous production et il faut parfois faire venir du lait des régions éloignées, des fruitières de Savoie particulièrement, mais son prix est relativement élevé car il se vend au cours du fromage de Gruyère fabriqué dans ces régions.

En été, au contraire, il y a surproduction très importante par suite de l'augmentation de la production et de la diminution de la consommation. Le marché est encombré de lait, la vente est difficile pour les laitiers et par suite les producteurs qui manquant de main d'œuvre ne peuvent fabriquer du beurre ou du fromage.

ORGANISATION DES LAITIERS DE LYON.

Elles sont de trois ordres:

1°. La Société Laitière Moderne, vaste organisation industrielle qui recueille environ 40,000 litres par jour qu'elle distribue dans ses petits et nombreux dépôts de quartier qui le vendent au consommateur. Elle est aménagée d'une manière très industrielle pour traiter le lait; son organisation lui permet d'envoyer en cas de surproduction six wagons de lait sur Marseille où, celui-là faisant toujours défaut, il est vendu à 1.20 francs le litre par suite du manque de nourriture à bon marché produite sur place et qui rend la production laitière très onéreuse dans cette région.

2°. La Coopérative Laitière Lyonnaise, société anonyme au capital variable, reçoit environ 20,000 litres par jour; elle est organisée pour la transformation du lait.

3°. Trois syndicats de petits laitiers (on entend par petit laitier un commerçant vendant de 50 à quelques centaines de litres de lait par jour; il tient en général à côté de son commerce de lait une boutique de fruits, primeurs): Le Syndicat Général des Laitiers de Lyon, l'Avenir régional (section de laiterie et crèmerie), groupement coopératif des laitiers des Brotteaux (la gare des Brotteaux est une des grosses gares d'arrivage de lait de Lyon). A côté se trouve installé une pasteurisation indépendante de ces groupements; l'industriel fournit les appareils et la chauffe; il prend 0.02 par litre, le laitier fournit la main d'œuvre. Actuellement ces laitiers ne sont pas organisés pour effectuer la transformation de la surproduction laitière en beurre et fromage, mais il est possible que dans un temps plus ou moins proche ils essayent de s'organiser à ce point de vue.

Organisations de producteurs.—Jusqu'en 1921, à part deux groupements importants, aucune union sérieuse de producteurs de lait n'était en présence des organisations des laitiers, aussi ces derniers en profitaient-ils pour fixer les prix d'achat du lait à leur fantaisie sans tenir compte des dépenses nécessités pour produire un lait bon et hygiénique. Au début de l'année dernière le lait eut à subir à la production une baisse atteignant parfois jusqu'à 40 pour cent alors que à la consommation celle-ci n'était plus que de 10 pour cent. Les agriculteurs fort mécontents de se voir ainsi traités sentirent le besoin de s'unir pour éviter le renouvellement de semblables baisses et être en état d'opposer aux syndicats des intermédiaires par une union ferme et bien dirigée. Des associations des producteurs se formèrent alors dans les environs de Lyon jusqu'à une soixantaine de kilomètres de cette ville; elles organisèrent leurs groupements selon les voies de chemin de fer qui desservent la production de la région.

Il existe actuellement:

1. Le Syndicat d'Initiative des Producteurs de Lait de la Région Lyonnaise, qui englobe toute la ligne de Lyon à Bourg comprend une trentaine de communes environs.

2. La Fédération des Producteurs de Lait de la Ligne d'Amberieu; 35 communes, 3 gares de chargement de lait—Leyment, Montluel, Meximieux. C'est une union de syndicats communaux ayant élu un bureau avec un président pour s'occuper des questions laitières. C'est la ligne qui apporte le plus de lait à Lyon, 50,000 hectolitres par an.

3. Le Syndicat des Producteurs de Lait de la Région d'Heyrieux, Ligne de ravitaillement: Chemin de fer Lyon-Bourgoin-tramway Lyon-Côté St. André. Il comprend une vingtaine de communes. Ce n'est pas une union de syndicats, mais une organisation régionale; elle comprend surtout des laitiers et ramasseurs, ce qui semble unir à son essort. Des délégués sont nommés dans chaque commune pour étudier le commerce du lait. Ces organisations ne veulent pas les unions de syndicats communaux.

4. Syndicat des Producteurs de Lait de la Région de la Tour-du-Pin. Ligne de ravitaillement; Lyon-Bourgoin, mais de l'autre côté de Bourgoin. Organisation semblable à la précédente avec délégués communaux dans 11 communes, mais elle ne comprend que des producteurs.

5. L'Union Laitière du Nord-Dauphinois, dont le siège est à Morestel (24 syndicats); elle envoie depuis deux ans son lait à Lyon.

Il est pris entièrement par la Société Laitière Moderne qui y fait ses prix: 0.05 à 0.10 le litre plus bas que partout ailleurs; elle comprend 26 syndicats communaux ayant une organisation centrale. Ligne indirecte locale de Lyon à St. Genix.

6. Fédération des Syndicats des Producteurs de Lait de la Région Lyonnaise (section du Rhône). Même genre de groupements que la précédente union. Elle comprend 23 communes sur les lignes de Lyon à l'Arbresle et de Lyon à Mornant.

7. Union Laitière de l'Est de Lyon (centre St. Priest-Pusignan), 12 communes.

Dans les régions plus éloignées de ravitaillement par Lyon, il existe des groupements de producteurs. Il en est ainsi pour Vienne, Grenoble, etc.

(Voir le compte-rendu de la Journée du Lait. Rapport de M. Saint-Olive.)

D'autres sont en formation.

Une fois ces unions constituées, elles éprouvèrent le besoin de s'unir entre elles pour présenter avec plus de poids leurs revendicateurs en face des laitiers et des consommateurs; elles nommèrent un président celui de l'Union Laitière du Nord-Dauphinois. Il fut décidé alors vers novembre de créer à Lyon un organisme, le Secrétariat Central du Lait, chargé de centraliser tous les renseignements concernant la production laitière; d'entrer en rapports avec les intermédiaires et d'aider par ses recherches tous les agriculteurs ayant besoin de son concours. Il est pourvu d'un titulaire depuis trois mois.

Avant de nous occuper des travaux qu'il a entrepris il est bon d'étudier la production laitière.

Production laitière.—Dans les environs immédiats de Lyon il n'y a pas de races bien définies. Plus loin, au nord comme au sud, à l'est comme à l'ouest, se trouvent des régions d'élevage d'animaux remarquablement bien sélectionnés enviés par l'étranger, comme les Charolois pour la boucherie, les Limousins pour le travail et la viande, les Montbéliards pour le lait, comme belles races de Montagne, la Tarine et la Villard-de-Lans. Notre ville étant aux confins de toutes ces régions, il en résulte de perpétuels croisements. En outre, la région se prête mal à la production de bêtes de qualité et le commerce du lait est plus rémunérateur que l'élevage. Ici c'est la petite propriété, chaque agriculteur a quatre à cinq vaches au plus.

La production moyenne d'une vache par an est de 1,800 litres pour un animal ne travaillant pas; 1,200 par celles qui effectuent les travaux des champs. C'est un rendement faible expliqué par la mauvaise nature du sol des prairies et la sécheresse du climat. Quelques améliorations peuvent pourtant être apportées.

L'hygiène des animaux des étables et de la traite n'est pas toujours aussi satisfaisante qu'on pourrait le souhaiter.

Ramassage.—Une fois le lait tiré il faut le mener à Lyon. Il y a trois méthodes employées.

1. Certains groupements de producteurs (ligue de Bourg, par exemple) ont un ramasseur qui travail pour leur compte et est rétribué par eux, ce procédé laisse le maximum de bénéfices aux producteurs.

2. Une organisation semblable existe aussi, mais en sens inverse, pour les grosses sociétés laitières qui ont des employés chargés de ce service.

3. Le cas le plus fréquent est celui où le ramassage est effectué par un individu travaillant pour son propre compte et prélevant lui-même son bénéfice.

Le lait voyage en wagons ordinaires en général à claire-voie. Il arrive dans la matinée et est immédiatement emmené à la pasteurisation. Les grandes sociétés ont ce service directement installé dans leurs locaux et ensuite elles distribuent le lait dans leurs dépôts. Les petits laitiers viennent chercher leur lait personnellement ou par petits groupes et pasteurisent, comme il a été dit plus haut.

Secrétariat central du lait.—Depuis trois mois il fonctionne normalement. Son titulaire a eu à se mettre au courant des organisations laitières et de toutes les questions, aussi nombreuses que variées, touchant au commerce du lait. Les principales études qu'il a entreprises sont:

1. Une enquête dans les divers villes de France pour obtenir une documentation complète sur les cours et commerce du lait.

2. Une étude détaillée de la législation de la fraude pour aider les producteurs injustement poursuivis à se défendre.

3. Un travail sur les questions de transport.

4. Il a pris une part active aux débats qui ont eu lieu entre laitiers, producteurs et représentants des consommateurs.

5. Il a enfin étudié un certain nombre de questions de tous ordres: prix du lait dans la région lyonnaise débouchés divers pour les divers productions laitières, etc.

Il compte entreprendre les travaux suivants:

1. En premier lieu affermir et donner une vie plus intense aux groupements de producteurs déjà existants et pas très bien organisés.

2. Grouper les syndicats de certaines régions et les fédérer en unions laitières, créer des syndicats là où il n'en existe pas.

3. Etudier les moyens d'établir une organisation laitière capable d'utiliser et transformer la surproduction laitière en beurre, fromage, pour éviter que les laitiers ne laissant parfois aux cultivateurs le produit d'une traite ou de plusieurs et les pertes qui en résultent par suite de l'événement du produit et de la surabondance qui fait baisser les cours par suite du jeu de l'offre et de la demande.

4. Au sujet des fraudes il a l'intention d'entreprendre avec un laboratoire une série de 1,200 analyses d'échantillons de lait portant sur la durée d'une année, pour déterminer quelles sont les causes qui influent sur la teneur du lait en ses divers éléments et tout particulièrement sur la matière grasse et les limites de ces variations.

5. Il tâchera d'amener le producteur à améliorer les conditions d'hygiène et d'élevage.

6. Il entreprendra aussi sur place les études sur les besoins de la production et les moyens de provoquer les améliorations indiquées plus haut.

[Abstract.]

THE PRODUCTION AND DISTRIBUTION OF MILK IN THE VICINITY OF LYONS.

R. GUYOT-SIONNEST, Central Dairy Bureau, Lyons, France.

The community of Lyons has a population of some 700,000 inhabitants who consume 120,000 liters of milk per day in winter and 95,000 liters per day in summer. In winter the scarcity of milk

makes it necessary to obtain more from Jura and Savoy. In summer there is an excess of milk due to a decrease of about one-sixth in consumption and an increased production of about one-fourth. The sale of the milk is difficult for the producers, and because of lack of help they are not able to make the excess into butter and cheese.

Organization of the dairymen.—1. The Modern Dairy Society Co. is an active industrial enterprise that handles, through its various district stations (between 50 and 60), 40,000 liters per day. In the summer it ships milk to Marseilles which is always in need of milk, due to the high expense of keeping cattle.

2. The Lyons Cooperative Dairy receives 20,000 liters per day; like the preceding organization, they are able to manufacture their milk.

3. Three syndicates of small dairymen (these selling from 50 to some hundreds of liters per day to small groceries, delicatessens, etc.). They are not organized for the conversion of milk into other products. Their milk is Pasteurized by an independent plant which furnishes the heat, materials, etc., at a charge of 30 centimes per lots of 16 liters. The dairyman furnishes his own helpers.

Organization of the producers.—In 1921 there were two important groups. At that time the dealers had subjected the producers to successive cuts in prices until they were unable to make sufficient profits to cover the cost of production. This paved the way for organizations which could cope with the middlemen.

At the present time there are seven of these groups, located along the railroad lines which serve their communities. Several of these groups are collecting centers for their respective districts.

All of these organizations, or unions, are under the direction and development of the Union of Southeastern Agricultural Syndicates (900 syndicates, 200,000 members).

Milk production.—This is rated at about 1,800 liters per cow (but lowered to 1,200 if the cow is worked in the field). Within 100 kilometers of Lyons there are some fine breeds, namely, Charollaise, Montebeliarde, Tarine, Villard-de-Lans, but because of the crossing of these different types of animals in the neighborhood of Lyons and those coming from a distance—the Normandy, Hollandaise, etc.—the crossbreeds are so numerous that the animals do not possess a fixed conformity. There is a marked tendency to adopt the Montebeliarde as the typical breed. Our sole purpose being centered on the production of milk, we have tried to assist in improving the herds by introducing good bulls regardless of the various individual qualities of the breeds.

Collection of the milk.—This is done in the following ways: (1) By collectors under the direction of the various syndicates; (2) by employees from the large dairy companies; (3) by a middleman. From the first two classes the costs run about 0.2 to 8 centimes per liter, depending upon the length of haul, condition of the roads, etc. The cost of transporting the milk by rail is about 3 centimes per liter.

Central dairy bureau.—This is an organization dealing with the study and investigation of milk and it is placed in the hands of the dairy farmers. It aids them in selling their products under better conditions, informs them of the improvements being introduced in the milk trade, discusses the questions of interest to the trade; sale

of milk in France and other countries, means of transportation, legislation for adulteration, and the causes affecting the composition of milk, retail prices, etc. In a word, it tries to inform the producer on all questions pertaining to milk.

THE METHODS OF MILK COLLECTION, TREATMENT, AND DISTRIBUTION USED BY THE BELFAST COOPERATIVE SOCIETY, LIMITED.

J. HILL, dairy manager, Belfast Cooperative Society, Ltd., Belfast, Ireland.

The society's board of management as far back as 1912 were not satisfied with the new milk supply for the city of Belfast. The quality was not always what it should be. The delivery from door to door in open cans left a great deal to be desired.

The uncertainty of a sufficient supply of pure new milk reaching the members of the society, irrespective of weather conditions, caused the management to set about getting information, preparing plans and specifications, erecting and equipping what was in 1913 the most up-to-date dairy known.

The plant consisted of a cleaner, Pasteurizer, cooler, bottler, and cold store capable of handling 440 gallons per hour. The daily output was under 3,000 pint bottles.

A great deal of prejudice existed in most people's minds in favor of natural or untreated milk, especially where babies were concerned. To combat this, the society published literature explaining the system of treatment, organized illustrated lectures by leading scientists, made a systematic canvas of the membership, demonstrated the safety from epidemic enjoyed by users of Pasteurized milk as against untreated milk, also the economy effected—as every drop of the milk scientifically treated can be used by the purchaser, whereas the purchaser of natural milk always has about a tablespoonful in the bottom of each pint bowl which is not usable on account of the deposit of foreign matter. This deposit is highly dangerous if it finds its way into the food of infants or invalids. It is not desirable that even healthy adults should partake of it.

Sales increased just as the want of knowledge decreased, making it necessary to add new floor space one and a half times larger than the original dairy, and a new plant was installed capable of handling 880 gallons per hour.

Not being content to stand still and let others lead the way with newer and better methods of dealing with the milk problem, the management erected a retarder (continuous flow type) holding the milk for 30 minutes at 145° F., with a capacity of 880 gallons per hour.

To secure a sufficient supply of milk during the period of shortage between October and February of each winter gave this management very serious trouble as well as added expense in hunting for accommodation milk. To remedy this it was decided to purchase, during the five summer months when milk was plentiful and cheap, about 20 per cent over our requirements.

This surplus milk could not be disposed of as sweet milk even at a reduced rate. A churning plant was erected, consisting of one

265-gallon combined churn and butter worker and three ripening vats, each holding 265 gallons. These vats are fitted with cold water, steam, and brine. The milk is Pasteurized in the vat to 190° F., cooled to 80° F., inoculated with pure culture and allowed to ripen for churning. The result is a beautifully flavored butter of good keeping quality and buttermilk that finds a ready sale amongst the members and their friends. Often the van men have been asked to call and supply houses with sweet milk so that they may get a supply of butter and buttermilk.

The 20,000 gallons per week line was reached and the management decided on a bold move, viz, to provide accommodation for handling 50,000 gallons per week. Accordingly, plans were prepared, buildings erected, another 880 gallons per hour plant purchased, in which are included a new positive batch retarder and automatic rotary filling and capping machines, with a capacity of 1,760 gallons per hour.

The society acquired several of the best dairy farms in the County Down, where milk and eggs are produced for the dairy department under ideal conditions. The herds of British Friesian and Short-horns are the best in Ireland. Milk records are kept, unprofitable animals sorted out, and disposed of at the fat-cattle sales. Each animal is certified free from tuberculosis, the milk is carefully treated and sold as baby's milk.

Arrangements have also been made with several other very large and up-to-date dairy farms in the counties of Down and Antrim for additional supplies. These are run on the most scientific lines and are properly inspected by the local authorities officer as well as the society's own veterinary. No detail is neglected which would tend in any way to improve the quality of the milk.

Motor traction was tried in two districts and rail in another two. It was found that the motor costs were slightly lower than the rail costs, and at the same time the milk is under the control of the servants of the society from the time it leaves the hands of the producer till it arrives at the dairy. Every care is exercised in transit so that the milk arrives at the dairy without being contaminated. Last, but not least, unsettled conditions of labor on the railways in the past have been a source of great anxiety to dairymen. Six 4-ton cars and three $\frac{3}{4}$ -ton cars are engaged every morning and cover journeys varying from 12 to 40 miles.

Immediately on arrival at the dairy, the milk is tested for acidity, then starts an extensive process of purification, passing through a special strainer into the receiving tank, flowing over the warmer at 90° F. into a low-speed centrifugal cleaner, which not only takes out all foreign particles but aerates and purifies the milk from bad odors. The Pasteurizer then heats it to 145° F. and passes it on to the auto continuous batch retarder which holds every single drop of milk at 145° F. for 30 minutes. The cooler, of the flat capillary type, using water and brine, reduces the temperature to 40° F., and the milk flows on to the rotary automatic bottle filler and capper. From this machine the milk passes on to the cold store where the temperature is further reduced to 35° F.

As soon as the farmers' cans are emptied they are washed and sterilized before being returned to them next morning.

Bottles and crates are washed over four force pumps, then treated with live steam and kept in a cold room ready for receiving the next delivery of milk.

The members of the society have the assurance that their milk supply is going to arrive at their doors every day in the year in an unvarying condition of absolute purity, that no matter how many epidemics are about, or what weather conditions obtain, they can count on their milk being delivered punctually and completely germ-free.

Platform arrangements have been provided for loading 30 vans in 60 minutes so that the men get away to their districts early.

The city is divided into 27 districts, each of which is supplied with bottled milk from horse-drawn four-wheel vans. The suburbs are divided into three districts supplied with bottled milk from motor vans. To give workers an opportunity of purchasing the same quality of milk in bulk, 13 depots have been opened where they can get supplied at 1 penny per quart cheaper.

There is no need to emphasize the immense food value of milk. Everyone recognizes the fact that milk is one of the essential sources of nourishment which can not be dispensed with. Nevertheless it is doubtful whether the majority of the people are sufficiently alive to the vital importance of obtaining not merely a daily supply of milk, but a daily supply of purified milk which has been scientifically cleansed and from which all germs and impurities have been removed. To encourage farmers to keep good cattle and to feed them well, a standard of 3.6 per cent butterfat has been set up, for which an agreed upon price is paid. For each point above 3.6, 1 farthing per gallon is added; for each point below 3.6, 1 farthing per gallon is deducted. By this system a very much better quality of milk has been secured than when a flat rate was paid.

Meetings are held on the first Friday of April and September to fix the price for five summer months and seven winter months. Farmers send three delegates from each car route, the society sends four members of the board of management, the secretary and the dairy manager. The officials and staff take off their hats to the past, remembering the difficulties, the struggles, and the achievements they have experienced. They take off their coats to the future; now they have got a grip, they mean to hold on and press forward to the 50,000 gallons per week line inside the next five years. They have set up a standard of 100 per cent efficiency in every detail of dairy work and will not be satisfied until they have attained it.

Again, as regards the staff, no risks are taken. Every man employed is thoroughly trained and an expert in his work. Nothing is left to chance. From first to last, the various processes are carried through under the most favorable conditions by experienced operators.

Seldom a day passes but letters, telephone messages, and personal congratulations are received in praise of the products of the dairy.

From November, 1913, to February, 1923, a surplus of £27,710 19s. 9½d. has been divided amongst the members on their milk purchases alone on a poundage basis.

(a) Every branch of the women's guild will be visited during the winter of 1923, showing photographs of our buildings, plant, treat-

ment of milk, samples of untreated milk, samples of bottled milk ready for delivery, samples of contents of cleaning machine after milk has been cleaned, and samples of natural milk purchased from ordinary milk venders.

(b) Vigorous propaganda in the daily press.

(c) Attractive posters advocating the use of more milk per capita.

There should be time set apart in all primary schools in agricultural districts for teaching pupils the best breeds of cattle for the dairy farmer to keep, the proper way to house cows, the most nutritive and at the same time the most economical food for cows.

The pupils attending city as well as country schools should be taught the nature and importance of milk as an article of food, the importance of cleanliness and fresh air in the cow sheds where the milk is produced; cleanliness and fresh air where the milk is treated, and cleanliness and fresh air in the homes where the milk is kept and consumed.

LES DIFFÉRENTS SYSTÈMES D'APPROVISIONNEMENT DE LAIT EN ITALIE.

GIUSEPPE FASCETTI, de l'Institut Expérimental de Laiterie de Lodi, Italie.

La quantité de lait qui est annuellement nécessaire à la consommation directe en Italie peut être évaluée à 18,000,000 d'hectolitres, dont la plus grande partie est consommée dans les régions mêmes où la production du lait est la plus intense, comme la Lombardie, le Piedmont, la Vénétie, et l'Emilie.

La moyenne de la consommation annuelle de lait par habitant est de 45 litres.

Dans les centres très peuplés de la haute Italie, la consommation journalière est beaucoup plus forte que dans la campagne, et varie de 1 décilitre à 2 décilitres par habitant.

Le lait qui sert à l'approvisionnement des villes provient des campagnes environnantes.

Dans les villes il y a peu d'étables de vaches à lait parce qu'elles reviennent trop cher.

La vache à lait est soumise à un régime alimentaire qui varie selon les saisons et les régions.

Dans les régions où l'agriculture est plus avancée, comme dans l'Italie du nord, les vaches sont soumises au régime de la stabulation permanente, et on se contente de les mettre quelque temps au pâturage en liberté vers la fin de l'automne.

Les aliments fondamentaux qui sont consommés pendant l'été sont les fourrages verts de prairies naturelles ou artificielles ou de près secs, et pendant l'hiver les foins avec supplément de ration à base de tourteaux de son, de farines, etc.

Aujourd'hui l'habitude se répand, spécialement dans l'Italie septentrionale, d'employer les foins de silos: ce sont des herbes desséchées jusqu'à la moitié ou environ les deux tiers de leur poids, et ensuite comprimées en silos dans des constructions en pierre, à l'abri du contact de l'air.

Dans l'Italie centrale prédomine le système mixte; d'une part la stabulation permanente et d'autre part le pâturage en liberté.

L'alimentation est à base d'herbe des près, de feuilles d'arbres; et pendant l'hiver, de foin, de paille, des raves, et des betteraves, etc.

Dans l'Italie du sud prédomine le pâturage en liberté, et dans certaines régions (Sardaigne, Sicile) le bétail ne rentre pas même pour la nuit à l'étable.

L'alimentation y est toujours maigre pendant l'été alors que les grandes chaleurs dessèchent toute végétation herbacée.

Dans des conditions aussi différentes la production annuelle du lait, dans les diverses régions et pour les diverses races de bovines, est très variable.

Dans l'Italie du nord, où prédomine la race alpine brune et la race Schwytz pure ou croisée, et un peu la race hollandaise, dans les meilleures conditions la quantité moyenne de lait fournie annuellement par tête, durant la période de lactation, oscille entre 2,500 et 3,000 litres.

Exceptionnellement on arrive même à 3,500 litres là où les vaches laitières sont l'objet de beaucoup de soins.

Dans l'Emilie on table sur une production de 1,800 à 2,000 litres.

Dans l'Italie de sud, sur une production annuelle très basse, oscillant de 500 à 1,000 litres.

Ainsi la moyenne de la production de lait quotidienne par tête oscille dans les meilleures conditions entre 7 et 8 litres, pour descendre à 2 et 3 là où le bétail est peu soigné et où les conditions du sol et du climat nuisent à la production du lait.

Le transport du lait des étables aux lieux de vente en détail ou aux laiteries de ville a lieu généralement deux fois par jour.

On réfrigère rarement le lait à l'étable, et dans ce cas c'est l'industriel qui procure à son fournisseur l'appareil spécial qui est toujours à simple courant d'eau de puits.

L'emploi des antiseptiques est défendu par la loi.

Le transport pour les petites distances se fait au moyen de charrettes à chevaux, qui tendent aujourd'hui à être remplacées par des camions; pour une quinzaine de kilomètres ou pour de plus grandes distances, au moyen du chemin de fer.

Les récipients les plus communément utilisés dans ce but sont les bidons ou pots ordinaires Fleischmann à fermeture parfaite et d'une capacité de 50 litres.

L'organisation commerciale d'approvisionnement du lait pour la consommation directe comprend en Italie les systèmes les plus variés, en rapport avec sa consommation plus ou moins grande par la population et avec le niveau de leur civilisation.

Pendant que les systèmes les plus simples et les plus primitifs sont encore en usage dans l'Italie du sud, par contre l'Italie du nord adopte les systèmes rationnels et modernes qui vont jusqu'à l'organisation des grandes laiteries de ville.

On peut classer ces systèmes ainsi:

1. Distribution du lait au domicile du consommateur fait par chacun des producteurs de lait, possesseurs de quelques vaches.

2. Distribution du lait par l'intermédiaire des comptoirs de vente au détail dans les villes, tenus par de petits revendeurs qui achètent à tant pour toute l'année dans les alentours.

3. Distribution du lait faite par de gros industriels qui disposent d'installations modernes pour recueillir le lait de la campagne en grande quantité et le répartir ensuite entre les comptoirs des villes, fonctionnant techniquement, qui en font la vente; ou bien le distribuer à domicile au moyen de petits fourgons spéciaux.

4. Distribution du lait faite par associations des producteurs ou des sociétés, au moyen de laiteries de ville installées rationnellement.

Les systèmes ci-dessus indiqués sont pratiques quand il s'agit du lait que l'on recueille dans les campagnes qui entourent les villes qu'elles approvisionnent dans un rayon de 10 à 30 kilomètres.

Mais depuis quelques années c'est grandement développé l'approvisionnement du lait à grandes distances (100 à 600 kilomètres), pratiqué par des sociétés industrielles, des laiteries coopératives, ou de gros industriels, qui disposent d'une organisation parfaite pour recueillir, transporter, traiter hygiéniquement le lait et le distribuer dans les centres de consommation.

Ces organisations commerciales se trouvent toutes dans la haute Italie, et sont installées dans les campagnes les plus importantes pour la production du lait, ou elles le prennent pour le diriger vers les grands centres, généralement de l'Italie centrale, qui ne peuvent être alimentés de lait en suffisance par les campagnes environnantes. C'est dans ces conditions que se trouvent les villes de Florence, Ancone, Spezia, Gênes, Rome, Naples, Palerme, et quelques villes de l'Italie du nord, comme Bologne, Verone, Venise et Trieste.

Les principales sociétés et les principaux gros industriels qui ont développé l'approvisionnement du lait à grandes distances, sont: la société d'exportation Polenghi Lombardo di Codogno, la Fédération des Laiteries de Crémone, à la tête desquelles se trouve la Triulzi et de Casalpusterlengo; l'établissement pour la stérilisation du lait de Mortara, les laiteries de la Société Mattia Locatelli de Moretta (Cuneo).

Avec les systèmes de distribution réalisée dans les laiteries de ville par les grandes industriels ou les établissements qui recueillent le lait, se trouvent utilisés tous les moyens les plus perfectionnés pour traiter hygiéniquement le lait: filtration efficace avec disques de ouate, réfrigération avec des appareils à double courant, reliés à des installations frigorifiques, pour abaisser la température à 2° C., mise en flacons du lait avec fermeture garantie, stérilisation des récipients, etc.

Naturellement, selon la distance plus ou moins grande du lieu où est recueilli le lait, au lieu où il est distribué, les traitements d'hygiène varient d'intensité, et précisément pour les fournitures à petites distances on peut les distinguer en (1) filtration et réfrigération du lait à 5° C.; (2) filtration, pasteurisation et réfrigération du lait entre 5° à 10° C.

Et pour les fournitures à grandes distances (de 100 à 600 kilomètres) en (1) filtration, pasteurisation, condensation au quart du volume, réfrigération à 2° C.; (2) filtration, pasteurisation et réfrigération obtenue par le moyen de lait congelé, introduit par blocs dans chacun des bidons de lait, prêts à être expédiés.

Ces mêmes laiteries, dans les établissements qui recueillent le lait, produisent avec le lait qui n'élève pas la vente immédiate, du lait condensé en boîtes, du lait maternisé et homogénéisé en bouteilles pour nourrissons.

Le réduction du lait au quart de son volume est un procédé qui a été étudié et adopté en Italie durant et après la guerre, pour économiser les frais de transport et de récipients alors très coûteux.

Insistons sur ce procédé qui, croyons-nous, n'est pas aussi répandu à l'étranger que dans notre pays.

Le lait, à la laiterie qui le recueille, est d'abord filtré, puis pasteurisé à 75° C. dans des chaudières à fromages, puis évaporé dans une boule commune de concentration à pression réduite.

On le réduit au quart de son volume initial, puis des pompes le prennent dans le condensateur pour le porter dans un appareil réfrigérant à double courant qui en abaisse la température à 5° C.; de là il passe immédiatement dans des bidons de 50 litres stérilisés qui, dans des wagons frigorifiques, ou dans des voitures ordinaires avec réservoir à glace, sont expédiés dans les villes de distribution.

Dans ces villes se trouve l'installation de réintégration, où l'on contrôle le poids, la composition, l'état hygiénique du lait concentré, et où l'on en reconstitue ensuite le volume primitif avec de l'eau potable.

Dans ce but on se sert de chaudières de cuivre étamé dans lesquelles un moteur fait mouvoir un agitateur en forme de lyre, qui tourne sur lui-même, à temps accompli, un circuit tout le long de la périphérie de la chaudière.

Quand le lait donne l'impression d'être bien homogénéisé, on le fait passer au réfrigérant et on l'expédie en bidons dans les différents comptoirs de la ville qui en font la distribution aux consommateurs.

De ce qu'on vient de dire, on peut conclure que pour atteindre un plus grand perfectionnement ultérieur dans l'approvisionnement du lait en Italie, il importe de formuler les vœux suivants:

1. Que l'Etat favorise et encourage un contrôle sanitaire des vaches laitières dans les étables.

2. Qu'on fasse tous les efforts pour que le système primitif de la petite fourniture à domicile, exercée directement par le producteur, vienne à disparaître.

3. Que l'on donne dans les grandes villes un plus grand développement à l'installation des laiteries modernes qui seules sont en état d'organiser un service parfait, pour fournir du lait hygiénique et naturel sous la surveillance continuelle et facile des autorités communales.

4. Que l'Etat encourage la constitution de ces laiteries et en facilite le bon fonctionnement, en mettant à leur disposition des moyens de transport rapides et appropriés et en exerçant un contrôle rigide sur la vente du lait au public.

[Abstract.]

THE DIFFERENT SYSTEMS OF HANDLING MILK IN ITALY.

GIUSEPPE FASCETTI, Experimental Institute of Cheese Making, Lodi, Italy.

The quantity of milk needed annually for direct consumption in Italy is estimated at 18,000,000 hectoliters.

The average annual consumption is calculated at 45 liters per inhabitant.

In thickly populated centers of northern Italy the consumption is greater. It varies from 1 to 2 decaliters a day for each inhabitant.

The commercial organization which supplies milk in Italy includes the most varied systems, according to the rate of production of milk, its consumption by the population, and the standards of living.

The simplest and most primitive systems are still in operation in southern Italy, while in northern Italy rational and modern systems

have been adopted, which may be summed up in the organization of large dairies in the cities.

These systems may be classified as follows:

1. Delivery of milk at the home of the consumer by single producers owning some cows.

2. Distribution of milk by middlemen owning milk shops for retail trade in the city.

3. Distribution of milk by large firms owning modern plants for the collection of milk from the farms in great quantity, this milk to be distributed among sanitary, well-managed city shops, which either sell it or deliver it to homes by means of special trucks.

4. Distribution of milk by producers' associations or by companies through city dairies properly equipped. The milk is collected from the surrounding country over a radius varying from 10 to 20 kilometers.

5. Distribution of milk at great distances (from 100 to 600 kilometers) by the great industrial establishments of Lombardy (those of the provinces of Milan and of Cremona) for furnishing the milk supply to cities not sufficiently provided for by their surrounding territory; as, for example, Rome, Florence, Genoa, Trieste, etc.

It is needless to say that the hygienic treatment of milk varies according to the distance between the place of production and that of sale, both as to kind and intensity. For short distances the following treatment is adopted:

1. Filtration, refrigeration of the milk at $+5^{\circ}$ C.

2. Filtration, Pasteurization at 80° C. and following refrigeration of the milk from $+5$ and $+10^{\circ}$ C.

For furnishing milk at long distances the following treatment is adopted:

1. Filtration, Pasteurization at 80° C., condensation to one-fourth its volume, and refrigeration at 2° C.

Milk treated as above is sent to its destination in metal containers of 50 liters capacity, being transported in refrigerated cars. On reaching its destination, its former volume is restored by means of the necessary quantity of water.

2. Filtration, Pasteurization at 80° C. and refrigeration obtained by means of frozen blocks of milk placed in the milk containers.

In spite of the great progress which has been realized in Italy by means of these modern systems for the distribution of milk supplies, much remains to be accomplished, especially in those places where the population is still ignorant; therefore, the following suggestions are submitted:

1. That the Government favor and encourage a sanitary inspection of cows in their stables.

2. That every effort be made to abolish the old system of retail home delivery by the producer.

3. That in the large cities the installation of modern dairies be encouraged, as the latter alone are capable of organizing a perfect service which will supply the consumer with pure and hygienic milk under the constant and easy surveillance of the communal authorities.

4. That the Government encourage the establishment of such dairies by facilitating their functioning, placing at their disposition rapid and appropriate means of transportation, and exercising also a rigid control over the sale of milk to the consumer.

THE EDUCATION OF THE PRODUCER AS TO THE VALUE OF A BETTER PRODUCT AS A MEANS OF INCREASING SALES.

L. T. C. SCHEY, Ph. D., Government Dairy Counselor, Hoorn, Holland.

One of the means of attaining an increase in sales is to increase the professional knowledge of the producer. It is of great importance for the milk producer that the material should be of good quality, whether he makes the products himself or sends the milk to a co-operative factory to be converted for him. The quality of the products increases the market value and depends, for the greater part, upon the quality of the raw material. When the dairyman does not sufficiently lend a hand to increase the proceeds of his products as much as possible, by means of improving of the quality, though his personal interest demands it most decidedly, it must be partly attributed to his want of professional knowledge, in consequence of which he does not see the connection between his shortcomings and the consequences with respect to the quality of his products. He will cooperate more effectually, when he knows not only how he must do, but understands, at the same time, why he should do so.

The milk producer, who makes his own products, is apt to have a better insight into this matter, than the cow keeper, who has his material converted in the co-operative factory, and who sometimes has less interest in the manufacturing and the sale, than he would have if he supplied a noncooperative factory. For this reason his interest in the proceedings in the factory must always be excited and increased.

In the second place, the producer of an inferior material must be given a better insight, by being paid less for his products. If there existed a rational, practicable system of payment for milk according to ability to supply first-class products, the situation might be improved exceedingly. Something might be achieved by a premium bonus system with a view to encourage the improvement of the quality.

In the third place, the inspection of the milk production and the treatment of milk at the farms will have an educating effect. When the farms are visited, an excellent opportunity is afforded to impart a better insight to the producer, by means of instruction. Forceful means should be used when it appears afterwards, that the producer is not willing to cooperate. Punishing the unwilling producers is a thing of necessity, because those who are willing will be less inclined to do their utmost, when the pains taken by them stand the chance of losing their effect owing to the negligence of others.

In the fourth place, the examination of the final products and the payment according to quality will convince the producer, in a better way, of the value of a superior product.

As to manufacturing, the co-operative concern lends itself best for the application of the indicated measures, because the producer is continually interested in the greater or smaller success of the manufacture and the sale of the products; private industry, which buys the material in such a manner that the quality of the products to be made does not count, will impart a better insight to the producer, by bringing the quality and content of valuable components to bear as factors when the milk is bought.

SESSION 19, COOPERATIVE MARKETING OF MANUFACTURED PRODUCTS.

Chairman, JOHN D. MILLER, vice president and general counsel, Dairymen's League Cooperative Association.

Secretary, J. A. GAMBLE, professor of dairy husbandry, University of Maryland.

STRAND THEATER,
Syracuse, N. Y., Tuesday, October 9, 1923—9.30 a. m.

Chairman MILLER. The meeting will please come to order.

(Moving pictures of dairying in Switzerland were shown.)

Chairman MILLER. The first speaker on the program is Mr. Sørensen, who will speak on "Danish cooperative dairy organizations and their work."

DANISH COOPERATIVE DAIRY ORGANIZATIONS AND THEIR WORK.

SØREN SØRENSEN, agricultural advisor to the Danish Government, Washington, D. C.

The Danish dairy industry is highly organized through local, district, provincial, and national organizations.

In order to meet the demand for standardized products, the Danish farmers found it necessary to cooperate. In 1882, a few poor peasants in western Jutland (Hjedding Parish) formed a local dairy society and built the first cooperative creamery. The principles laid down in the laws and by-laws of this society proved to be the foundation on which the whole cooperative movement in the dairy industry was built. In the following, a very brief description will be given of the present organizations.

1. LOCAL COOPERATIVE DAIRY SOCIETIES.

There are at present 1,400 local dairy societies founded on a strictly cooperative basis, which means that:

a. The members bind themselves for a certain period, usually 10 years, to deliver to the society all milk produced in excess of that used in their homes.

b. All members are jointly and severally liable.

c. The proceeds are divided in proportion to the amount of milk delivered.

d. Membership is open to all milk producers.

e. Each member has but one vote.

f. The general assembly is the supreme authority in the society's affairs.

Each local society owns and operates a creamery, the supervision and management of which are intrusted to a board of directors elected

by the general assembly. The board also hires a technical manager to operate the plant.

The societies as well as the creameries vary considerably in size. The average society has about 150 members, with approximately 900 milk cows and a yearly output of nearly 5,000,000 pounds of whole milk.

The cooperative system has proved to be of the greatest importance in developing the Danish dairy industry to its present high level. As members of the societies and owners of the creameries, the farmers have become interested in producing the very best quality of dairy products. Efforts are made to deliver clean and fresh milk, and in most cases the societies keep the creameries well equipped with modern machinery; last, but not least, they understand that it is necessary to have able and well-educated creamery managers and butter makers in order to obtain the best results.

The whole milk is delivered each day to the creameries, where it is separated and a large part of the skim milk is returned to the farmers. The creamery managers, of course, have the power to refuse sour and impure milk.

The success of the cooperative movement can be measured by the fact that nearly 90 per cent of the total production of whole milk in Denmark is delivered to cooperative creameries. To avoid any misunderstanding, it may be well to mention that the societies are strictly cooperative and only receive milk from actual members.

2. DISTRICT ASSOCIATIONS.

Realizing that exchange of experience and discussions of matters of common interest are always valuable, the local societies have combined in district associations, of which there are at present 23, with a membership of more than 1,400 creameries.

The district organizations cooperate with similar organizations of the National Creamery Managers and Butter Makers' Association in organizing butter and cheese scoring contests, exhibitions of dairy products, meetings, etc. They have always been zealous in improving the quality of milk and dairy products, and are at present conducting a clean-milk campaign and agitating payment according to quality, based on the reductase test (worked out by Prof. Orla-Jensen, of Copenhagen).

In most cases the associations have a branch for insurance against foot-and-mouth disease.

3. PROVINCIAL UNIONS.

The district associations are organized in three provincial unions, representing the main provinces of the country. These unions cooperate with the general agricultural societies in arranging the large provincial dairy exhibitions, and they have yearly meetings where matters of common interest are discussed.

4. THE NATIONAL DAIRY ASSOCIATION.

The three provincial unions form the National Dairy Association (De danske Mejeriforeningers Fællesorganisation), which deals with important matters of general interest to the dairy industry such as

legislation, Government regulations, transport facilities, export, foreign markets, etc. The association maintains a statistical department which collects detailed information from the creameries in regard to membership, number of cows, amount of milk received, butter and cheese produced, expenses, such as wages, fuel, packing material, oil, salt, etc. A yearly statistical report is compiled which contains very valuable information regarding production and manufacture, as well as the management of the creameries. The statistical department also collects information from the creameries in regard to prices received for butter, and these data are compiled in a yearly report (Danmarks Smørpris-Statistik).

The national association appoints members to serve on different committees dealing with the dairy industry, such as the committee for butter quotation, the Government committee for dairy experiments, etc.

The association has been much concerned with the marketing problem. Delegations have investigated foreign markets and exhibitions have been held in different countries. Since the war endeavors have been made to develop a condensed-milk industry, which on account of the unstable conditions has experienced many difficulties, but is now on the upward trend.

In cooperation with the creamery managers' association, the national association has been successful in working out a wage scale for managers and helpers, which has proved satisfactory to both employers and employees.

5. BUTTER EXPORT SOCIETIES.

The dairy organizations have been mostly concerned with the management of the creameries and the technical improvements of the products. The marketing was for many years left entirely to the local creameries, and the dairy products were sold through private Danish firms and English wholesale houses. Dissatisfaction with the Copenhagen quotation in regard to "premiums," and the fact that butter was not always paid for according to quality, prompted the farmers in the late nineties to organize cooperative export societies.

There are at present 11 cooperative export societies in activity, with a membership of about 550 creameries, handling more than one-third of the total butter export.

The societies have, of course, met keen competition from private Danish concerns and English wholesale buyers, but notwithstanding this competition the cooperative societies have been able to maintain a steady growth.

The export societies pay their member creameries on a quality basis, which has been of great help in improving the quality of the butter. In many cases the societies receive a premium for their products on the world market.

The 11 societies sell independently, but they are combined in a national association which, through a board of directors, takes care of export matters of common interest, such as transportation, freight rates, butter quotations, etc.

6. DANISH CREAMERY MANAGERS AND BUTTER MAKERS' ASSOCIATION.

This national organization (Dansk Mejeristforening), which was founded in 1887, consists of 32 county organizations, with a total membership of about 2,200.

The creamery managers have, through their central and local organizations, taken a prominent part in the development of the Danish dairy industry.

The local organizations cooperate with the producers' district associations in organizing dairy exhibits, butter and cheese scoring contests, meetings, etc.

The national association has kept in close touch with the technical and scientific progress in the manufacturing of dairy products. It has also promoted the dairy schools affording the best possible education of those intending to become creamery managers and butter makers.

The association arranges short, practical courses in the different branches of dairy manufacturing, and supervises training of creamery helpers. It cooperates with the National Producers' Association in all matters concerning the dairy industry, and appoints members to serve on different dairy committees. Even in regard to wage scales there have so far been liberal agreements between the two parties.

The Creamery Managers and Butter Makers' Association inaugurated experiments in the manufacture of cheese, and employed an expert in cheese making to give advice to the creameries. Recently the association has been working on the standardization and marketing problems of the cheese industry.

The only Danish dairy journal, "Mælkeritidende," is published by the association and edited by its secretary.

The creamery managers, as well as their helpers, have always been faithful workers in the interests of the dairy industry, and the Danish farmers owe them a great deal of credit for the high quality of the Danish Lur-branded butter.

In this brief statement it has only been possible to mention a few of the most important activities of the Danish dairy organizations, but it will be understood that close cooperation is the foundation on which the Danish dairy industry is built, and that the producers as well as their employees are working together in order to obtain the best possible results.

Chairman MILLER. The Chair now takes pleasure in introducing to you Mr. John Brandt, who will speak on "A central cooperative organization for the marketing of butter."

A CENTRAL COOPERATIVE ORGANIZATION FOR THE MARKETING OF BUTTER.

JOHN BRANDT, president, Minnesota Cooperative Creamery Association.
St. Paul, Minn.

Mr. Chairman, friends: I have noticed through the whole program of the World's Dairy Congress, and the dairy council, and the demonstrations of the dairy council at the Dairy Show, that there has

been a good deal of emphasis placed on the importance of quality in our fluid-milk production. It seems that the underlying principle is to put the finest quality of product before the consuming public. The dairy organizations are bidding for the support and the consumption of their product mainly on that one principle.

In regard to the manufacture of butter, we have not heard so much about its actual quality. I think we all agree that if we are to bid for our share of business and maintain our standing with the consuming public we butter manufacturers must make a quality product in all of our butter manufacturing plants of the United States with as much thought as milk distributors give to the care and distribution of the fluid milk in our different cities.

I am going to outline briefly to you the actual workings of the cooperative creamery system in Minnesota. We are there laying our foundation for the production of a quality product. Our first aim is to obtain a product that we can advertise and put before the consuming public as a quality product. We should, in the butter industry, manufacture a product in such a way that we shall not be ashamed to have the consumer watch the process from the time the raw material leaves the cow until it reaches the actual consumer. There are times when the process of manufacturing butter would almost make the old cow blush, could she see the actual turns that the cream or the raw product goes through before it results in the finished product.

In Minnesota, our local cooperative creamery system was started between 30 and 40 years ago by the organizations of our first creameries, perhaps at Clarks Grove, Minn., or at Biscay. There is some discussion as to which should claim the honor of starting the first cooperative creamery in Minnesota. Before the beginning of the creamery system, as we have it now, each individual farmer was manufacturing his butter in the home, through the old hand method. We had as many different kinds of butter as we had different families which made the butter.

I want to emphasize the fact that it was necessary to band these individual workers together to standardize at least the product of one region. We were getting from 6 cents to 8 cents a pound for a product which went out from these homes to local buyers. We tried to induce them to join a cooperative organization. One farmer was getting 2 cents a pound more than his neighbor, who was not making quite as good a product. The farmers seemed at first unwilling to join hands, put their product into one pool, and manufacture one kind of butter in one community. But as this idea spread from one creamery to another, it was demonstrated that by getting together we profited by standardizing in the community. It seemed that the more good butter we made, the better price we could get for it.

The system has grown in Minnesota from the 1 or 2 creameries, until, at the present time we have over 600 cooperative creameries; 600 cooperative creameries that originally were operating and marketing independently of their neighbor creameries. We were manufacturing in these 600 cooperative creameries perhaps 600 different kinds of butter, marketing it by 600 different methods, and competing in perhaps 30 or 35 markets.

We realized that it would be necessary in localities of that kind to standardize as nearly as possible the butter from all these creameries. So for that reason the State creameries' association, comprising 16 districts, came into existence. There are from 25 to 40 creameries in a district, supervised by an expert field man, whose duty it is to visit the individual creameries and to adopt standardization programs, which, as nearly as possible, standardize the butter in the individual districts, according to specifications laid down by the State creameries' association. These 16 districts are federated into one State creameries' association, managed by 16 directors, one from each district, who supervise the work.

The by-laws of the association provide that each one of these directors must be either a patron or a director of a local cooperative creamery, so that the directing policy of the State creameries' association is always entirely in the hands of a member or members of the local cooperative creameries which are interested in the actual production of the butter.

I want to emphasize the fact that the main work of the association was the standardization and the improving of the quality of the butter in these local factories. Originally we took in all whole milk at the factories, which had to be absolutely sweet in order that it might be skimmed at the creamery. But as the hand separator came into use, the farmer thought that the cream must be soured anyway, and he turned in his sour cream. One creamery would take his sour cream if the quality were not so very bad. Soon it would take one, two, or three cans. Soon possibly one plant would take in 75 per cent sour cream. We all know that some of that sour cream is not of the very best quality. One plant would take sour cream, and presently 600 creameries, each working for the interests of the individual creamery, began to bid for this cream, and to compete with each other. If the cream were refused at one creamery because the quality was not right, another creamery would bid for it. Through competition among ourselves we were slowly decreasing the quality of the butter in the local plants.

The work of the State creameries' association was to enable the field men to prove to the creameries in the several districts the absolute necessity of the manufacture of a quality product, eliminating competition and bidding. We have eliminated a great deal of this competition through the work of the field men and the State creameries' association.

The next step of the State creameries' association was the buying of supplies for our creameries, cooperatively. We have just made our returns for 425 creameries, members of the association, for our first eight months' business through the supply department, which is operated on a purely cooperative basis and the returns made to the individual creameries on the basis of the actual purchases through the State creameries' association. It is truly cooperative; we buy at the cheapest possible points, in the cheapest way in which it is possible to buy, as cheaply as any other jobbing concern can buy, and often more cheaply, and the creamery pays the regular jobber's price for the product. At the end of the given periods, when we make the cut-off, we prorate back to the creameries, accord-

ing to the amount purchased through the association, the actual profits on their patronage. The supply department has demonstrated in Minnesota that it is a success, and I believe if all the rest of the association's work should fall by the wayside, the supply department would live. It has been a profit to the creameries.

We have not done this work of standardization among the creameries without having some particular goal toward which we are aiming.

It became necessary to organize our butter sales department. We are just starting on that now. We have something like 30 new contracts to our new butter-marketing plan. This plan has been presented only to about three groups of creameries, and has been taken up 100 per cent.

Our butter-marketing plan is very simple. We are grading the butter according to its quality. The butter from all of the creameries that have signed this butter agreement will be put into one pool, according to its quality. We will recognize several different grades. Our first grade will be sweet-cream butter, butter manufactured and churned absolutely sweet, so that the buttermilk from the churn will not curdle in coffee, nothing to be used that is not absolutely sweet, with an acidity of less than 0.24 per cent. Then we will have the light acid butter, and other grades, as we go down the line.

This butter will be concentrated at one point in St. Paul. One tub from each churning will be inspected. Churning certificates will accompany the different churnings, and one tub from each churning will be inspected at that point and placed in its proper grade.

Instead of 600 sellers of the butter of Minnesota, 600 different cooperative creameries competing for a few markets, we expect to have those markets competing for the output of the Minnesota creameries. This output will be sold by one department, our butter sales department. There will be one man in charge of the sale of the butter of that particular department. Instead of shipping all our butter to our eastern markets under a stencil number, when nobody except the shipper at the creamery and the man who buys it is able to tell the butter apart, we expect to put the butter out under our own brands and labels, and to bill from one selling association in St. Paul to points in the eastern markets. The butter will go to St. Paul to be graded; this will be an incentive to butter makers and managers of local creameries to produce the best possible grades. We are going to work to stimulate a greater demand for our sweet cream butter.

Instead of consigning all of this butter to eastern markets and overloading a particular market, we will give a more even distribution; instead of as many solicitors throughout the State of Minnesota as there are butter houses buying butter (the expense of these men must come out of the product), the man at the market can either buy direct from the association, with one representative, or can buy the quality that he desires by letter or order sent from headquarters. The State creameries' association will stand back of the quality and deliver the actual quality of goods that is demanded by the buying through the association. Many times the butter from our western

creameries is shipped to our eastern markets, and that same butter, on which we have paid the freight to New York or Philadelphia, is again shipped back across the continent, sometimes as far as California.

We will also try to eliminate some of the extra shipping of butter, which is all costly, and the cost for which must all come out of the association. Instead of perhaps 30 buyers, whose markets we are competing for, we expect to have several hundred markets in the United States competing for the output of the creameries of Minnesota, which they will go to one central organization to buy.

Just a word about our pooling contract. The creamery agrees to consign its butter, regardless of its quality, regardless of the amount it manufactures, unless it has at the present time some other contract it must fulfill first. When butter is consigned to the State creameries' association, we become the actual owners of the butter. We can store it; we can borrow money on it. We have a program for actual financing all the way through. The ownership of the butter is turned over to the central organization that does the actual marketing of the butter. We expect to make monthly pools. At the end of the month, we will pay back to the creamery, divide the amount of money received for a certain grade of butter in that pool by the number of pounds of butter in that pool, which will give the average price returned to the local cooperative creamery, after deducting the actual operating expenses of that department, and setting aside a small sum for emergencies and reserves.

We hope, through our standardization program, which we feel is our biggest work in Minnesota, to standardize a product that we can put on the market in car lots, butter of a uniform quality, so we will be able to secure better returns for the farmers. You only need to pick up to-day a Chicago market quotation, and you will notice that centralized car-lot butter, 90 scoring butter, which is a standardized car lot of butter, is selling for about the same price as 92 scoring cooperative creamery butter, and often a half a cent to a cent more, for the simple reason that it is standardized. They can buy a full carload of that particular kind of butter. The market quotation for that particular kind of butter is therefore higher.

Our aim is to get a market quotation for sweet-cream butter and in that way make it an incentive for the individual creameries, individual farmers, to work for better quality. As long as we are not able to get a market quotation for that fine butter, and are only paid a small difference, there is no incentive to deliver better goods to the creamery. That is one of the objects of the State creameries' association, to get better quality and correspondingly better prices, which we justly deserve by putting out a better quality. Our whole aim in this work is to produce butter of the finest quality and to market it under our own brand, in such a way that it will be a credit to the dairy indorsing it. We want to get to the point where we market under a brand that designates quality that will be nationally known, a brand that we can all be proud of, instead of marketing it under a stencil number which nobody knows, as we have been doing for the last 30 or 40 years. I thank you for your attention.

Chairman MILLER. The next speaker on the program is Mr. Mitchell, of Los Angeles, Calif., who will speak on "Cooperative marketing of butter on the Pacific coast."

THE COOPERATIVE MARKETING OF BUTTER ON THE PACIFIC COAST.

CLYDE L. MITCHELL, efficiency man, Challenge Cream and Butter Association, Los Angeles, Calif.

The first attempt at cooperative marketing of butter on the Pacific coast was through the Dairymen's Union of San Francisco, Calif. This company began operation in 1891. Its outstanding leader was Luis Tomasini; a progressive dairyman of Marin County. But as the movement was of large proportions, a number of other dairymen were also prominently identified with it. Racially, the Italian-Swiss dairymen were the predominating factors, although all nationalities then engaged in the production of butter in California, were represented. Stockholders lived along the coast in Sonoma, Marin, San Mateo, Monterey, San Luis Obispo, and Santa Barbara Counties. Altogether there were several hundred dairymen stockholders. There was no limit to the amount of stock that any individual could own, and anybody was permitted to buy stock. Each share of stock carried one vote.

When the Dairymen's Union started, there were no creameries in California, or at least none in the territory served by the new company. The dairies were large and each dairyman made butter at home. The feed conditions were very favorable during the winter, spring, and early summer. The climate was cool. Many of the dairymen were good butter makers, so much of the butter was very good, far better than is made by many of our large creameries to-day, but some was very poor, and no two lots were alike. Within two years after the time of organization, the introduction of the centrifugal cream separator brought about the building of public creameries. Within a very few years a large part of the dairymen stockholders became interested in the new cooperative creameries. Naturally the new creamery companies bought stock in the Dairymen's Union, which in many instances financed the cost of their building and equipment. At one time, 19 cooperative creameries, located in the counties mentioned, were marketing through the selling house. A considerable number of dairymen continued for many years to make butter at home, and much of this dairy butter was handled in addition. Therefore the volume of business done by the Dairymen's Union those first years was very great. For two years, a selling branch was maintained in Seattle, Wash., but this never paid.

The Dairymen's Union was a great disappointment to its stockholders. There was always dissension among the stockholders and directors. Naturally, the old-line commission merchants opposed cooperative selling. The management of the Dairymen's Union, through speeches and newspaper articles, continually embittered all competitors. Although the cooperative selling house distributed to grocery stores, hotels, and restaurants, it always had a very great surplus of butter which it must sell to its competitors. The opposition combined in a buyers' strike, causing heavy loss to the coopera-

tive, and almost breaking it up. Nothing was ever done by the Dairymen's Union to improve or standardize the butter made by its many shippers. The house sold as many brands as it had shippers and never tried to popularize the butter under one or two advertised brands. No butter was stored during the flush season against the time when most of the cows went dry. Little by little, the Dairymen's Union lost the support of the dairymen. The stock became more and more concentrated, and finally control passed out of the dairymen's hands entirely. It closed in 1908, after a 17 years' losing battle. Some old dairymen still refuse to take part in any cooperative enterprise because of their disappointment in this pioneer cooperative movement. Of 17 cooperative creameries which once shipped it their butter, but one, the Bodega Cooperative Creamery, at Bodega, Calif., still continues. Several people who later became prominent in San Francisco dairy produce circles got their first selling experience with the old Dairymen's Union. Most notable among these is Wm. H. Roussell, now president of the San Francisco Dairy Produce Exchange.

In 1916, the Oregon Cooperative Dairy Exchange opened in Portland, Oreg. It has always been felt by the men operating country creameries in Oregon that the centralized creameries in Portland buy cream all over Oregon, in competition with the very same cooperative and individually owned country creameries that ship them their surplus butter. Thirteen of these country creameries, mostly cooperative, organized the Oregon Cooperative Dairy Exchange.

We quote from a former manager:

The plan was to market all the surplus butter from the 13 country creameries that comprised the organization, through a market exchange in Portland. The creameries maintained their local sales, but were not allowed to reach out beyond their local territory. All butter beyond that was shipped to the Portland office. My reason for leaving the organization was that, instead of working for quality and uniformity in the products, the directors and members felt that the main object was to control the Portland market, which was of course impossible, as they were not interested in standardization and improvement in quality.

No effort was ever made by the Oregon Cooperative Dairy Exchange to sell direct to retailers or consumers. Butter was sold in bulk through an established dealer at 1 cent per pound commission on wholesale lots. Thus the road between producer and consumer was lengthened rather than shortened. Besides, there was an overhead expense, which was covered by one-fourth cent levy on all butter shipped to Portland; which proved insufficient. As the exchange accomplished no good and only created expense, it died early.

In 1917, the Oregon Dairymen's Cooperative League was organized on a much broader scale than the defunct Oregon Cooperative Dairy Exchange had been. It embraced creameries and cheese factories and a milk distributing plant in Portland. The plan was very ambitious. It was supported by the officials of the State agricultural college, and the dairy and food department. The dairymen freely signed ironclad contracts of a long duration. The dairymen in large numbers proved to be loyal, notwithstanding much hardship. But that is about the only virtue the movement ever did show. The growth was so much like a mushroom that no manager could be found competent to handle the business. The market-milk problems were

distinct from those of the creameries and cheese factories, and the two classes of plants should have been handled, at first at least, by separate organizations. Competitors spared neither money nor effort to disrupt the league. Many manufacturing plants having been purchased at war-time prices, it was never adequately financed, and, with poor management, early liquidation followed.

At about the same time that the Oregon Dairymen's Cooperative League sprung into existence, the Associated Dairymen of California began their meteoric career. Mr. J. H. Henderson, jr., a prominent Sacramento banker and dairyman, was the leader. It was proposed to organize the dairymen of the State of California into district associations. Among the districts organized were the Northern California Milk Producers' Association, the Central California Milk Producers' Association, the San Joaquin Valley Milk Producers' Association, the Imperial Valley Milk Producers' Association, the San Diego County Milk Producers' Association, the Bay Cities, etc. The Associated Dairymen of California was to be the keystone of the arch, the source of inspiration and the selling organization. The plan as unfolded was Utopian. The leaders were strong for organization. Dairymen signed in large numbers. But the organizers did not prove to be competent business managers. Old plants were bought right and left at staggering prices. Elaborate new plants were erected and equipped at enormous cost. The Associated Dairymen of California never was able to function as a selling organization. Its physical assets finally went to the Milk Producers' Association of Central California, after all of the other district organizations had withdrawn. These assets consisted of one roll-top desk and three chairs. A number of the district units continue to operate independently, some of them enjoying competent management and doing well by the dairymen. About the same causes existed for the failure of the Associated Dairymen of California as for the Oregon Dairymen's Cooperative League.

From what I have told you up to this point in my brief historical sketch of the cooperative marketing of butter on the Pacific coast, you would be justified in concluding that large cooperative marketing of butter on the west coast has been entirely a failure. But there is another chapter to the story.

About 14 years ago the dairymen of Tulare County, Calif., were being served by three privately owned creameries. "Served" as the owners of the creameries put it; "robbed" as the dairymen felt about it. Finally it leaked out that two of the three creameries were secretly owned by the same company. The dairymen organized and decided upon the construction of the dairymen's cooperative creamery. About 200 dairymen joined the association, with membership fees at \$100 each. Mr. J. P. Murphy, a man with a lifetime of experience in the dairying and butter-making business, but at the time dairy inspector for the State dairy bureau, was employed as the first manager. The creamery opened with a big barbecue, and 3,000 pounds of butter were churned from the first day's cream.

From the start, Mr. Murphy wanted to open a distributing house in Los Angeles so as to sell under the creamery brand direct to the retailers. The directors were more conservative, and what appeared

to be a favorable contract, based on the Los Angeles Wholesale Produce Exchange butter quotations, was entered into with one of the established butter dealers in Los Angeles. Immediately after shipments started, the Produce Exchange so changed the method of quoting butter that the creamery automatically received a much lower price for its butter relative to its actual value than the directors had expected. It was only after much unpleasant bickering by the wholesale dealer, ending with the threat to discontinue shipments, that the wholesaler agreed to pay a fair price. This was in April, 1910.

Business with the new creamery then ran smoothly until September. Meanwhile the receiver of the butter had been storing heavily. The quotation for fresh extra butter advanced sharply on the exchange. The holders of cold-storage butter were anxious to liquidate their holdings, and the heavy arrivals of fresh butter were in the way. The Dairymen's Cooperative Creamery Association received notice from the wholesale house that their butter was no longer an "Extra" as called for by the contract, and that any further shipments would not be received.

Manager Murphy rushed to Los Angeles and found there that no one would buy any more fresh butter. All dealers were trying to move their cold-storage stocks. He then went to San Francisco, but found the situation there identical with that in Los Angeles. He then returned to the creamery. He found the molds all full of butter, the shipping cases all full, and butter piled high on boards laid on the floor in the butter room. In spite of the high market, the creamery had to pack into cubes and ship to cold storage. It was only after some time and by shipping to a number of wholesale dealers at sacrifice prices that the butter was finally sold as fast as churned.

This experience was a severe jolt to the creamery, but the lesson was not lost. The directors now became convinced that cooperative marketing was fully as important as cooperative manufacturing. It was determined to establish a butter house in Los Angeles. Meanwhile the Riverdale Cooperative Creamery, at Riverdale, Fresno County, was under construction, and it was decided by the two associations to cooperate in the marketing end, and to sell their butter under the name "Challenge brand." I had what was then the doubtful honor of being the first manager.

The Challenge Cream and Butter Association opened for business January 1, 1911. The beginning was very modest. There were only three employees besides the manager, an assistant manager, the book-keeper, and the delivery man. Deliveries were made with a one-horse wagon, but these were very light at first. None of us had had any previous experience in mercantile lines, and we had to make up with hard work what we lacked in experience. An average day started at 5.30 a. m., with cutting some cold-storage butter into prints for second grade. The fresh receipts were always cut and wrapped at the creameries. As soon as the grocery stores opened, the sales manager was out after customers, carrying samples of butter in a small satchel. But the answer was much the same everywhere: "We never heard of Challenge butter. First create a demand, then we will stock it." Toward 4 o'clock in the afternoon the grocers

became too busy to talk with salesmen selling things they did not want. We then returned to the store, where all hands kept busy until closing time.

Nearly everyone prophesied an early failure. They said, "No one connected with the house knows anything about business, and the house has behind it only a bunch of farmers who can never stick together." Sales picked up very slowly at first, and about two months after opening a committee came down from the creameries to learn why we were not selling more butter. The outlook often did appear very blue, but we never despaired of ultimate success, for we knew that our dairymen were standing solidly behind and that Challenge butter was the best butter in Los Angeles. We had been operating about six months, when a manager employed by a competitor dropped in one day, and said: "Mitchell, we gave this business three months to go; it is now six months. I believe now it is going to stick."

After six years, the Danish Creamery Association at Fresno, Calif., applied for membership in the Challenge Cream and Butter Association, and was admitted. This creamery does more business than any cooperative creamery that we have heard of in the United States. It churned during 1922, 3,461,251 pounds of butter. Danish creamery butter has won more first prizes and gold medals than any other butter in California. It was always able to maintain a premium of 1 to 2 cents over any other brand. Even in Los Angeles, Danish creamery butter in competition with Challenge butter always brought a higher price. But the Danish creamery was selling through a commission house, while the Challenge creameries were selling co-operatively. Retailers and consumers paid more for Danish creamery butter, but the Challenge creameries received the highest net returns. This fact, together with a natural desire to cooperate with the other creameries, prompted the Danish Creamery Association to join the Challenge Cream and Butter Association.

Imitation is the sincerest form of flattery. A second cooperative butter house was established in Los Angeles, the Golden Crown Butter Co. This was owned and operated by the Visalia Cooperative Creamery, at Visalia, and the King's County Creamery Association at Lemoore, Calif. In the spring of 1920, the directors of the two cooperative butter houses became convinced that their mutual interests would be best served by cooperation rather than by further competition, even of a friendly nature. Therefore, on May 1, 1920, the two organizations were fused under the name of the larger and older organization. In January, 1921, the Harmony Valley Creamery Association at Harmony, Calif., was admitted to the selling house. In January, 1922, the Imperial Valley Milk Producers' Association, at El Centro, Calif., was added to the list of member creameries, and in October, 1922, the Gustine Creamery Co., of Gustine, Calif., joined, making a total of 8.

After a little over nine years as sales manager, I resigned, as I felt the need of a change of occupation, and moved to a dairy farm. Mr. C. W. Hibbert, who had been with the firm as bookkeeper almost from the beginning, was chosen as my successor. Under his able management, the volume of business was tripled. After a year of retirement I was again employed by the association as superintendent of manufacture, for it was found that with so many creameries there

must be some one to work for efficiency in the various plants and to maintain a high and uniform quality. Mr. J. P. Murphy, the old war horse of the farmers' battles, in 1920, realized his dream of living on the farm, surrounded by his trees and vines. He then retired from the management of the Dairymen's Cooperative Creamery and the presidency of the Challenge Cream and Butter Association, for the founding and establishing of which he probably more than any other deserves the credit. Mr. W. J. Higdon, of Tulare, is now our president. Mr. Higdon is a Holstein breeder of national renown. He has always given his time freely while filling various positions of responsibility in the cooperative movement. We are all proud of our president.

The Challenge Cream and Butter Association is now owned by eight large cooperative creameries. In each creamery association each member is limited to one share and one vote. Each creamery association elects three directors to the board of directors of the Challenge Cream and Butter Association, making in all 24 directors. Each creamery is entirely independent in all local affairs, but the selling house is the sole agent in the marketing of all dairy products except such as are sold in their local territory. The rights of the selling house are now protected with a 44-year contract with each creamery. Each creamery ships its products to the wholesale house, which sells them almost entirely in a jobbing way to the retail grocers, markets, hotels, restaurants, cafeterias, hospitals, etc. The full amount of the collections, less actual selling cost and a small amount for reserves, is returned to the member creameries.

The business of the Challenge Cream and Butter Association has now grown to proportions hardly expected by the original founders. Sales of butter, mostly under the Challenge and Danish brands, amount to over 35,000 pounds daily, or over 40 per cent of all the butter distributed from the Los Angeles market. Eighteen neatly painted and lettered trucks are required to make deliveries. While butter is still the main product handled, attention is also given to sweet cream, cheese, plain condensed skim milk, sweetened condensed skim milk, and eggs. We also have a branch in San Diego. Losses on accounts are comparatively small, for 1922 amounting to only 5 cents on each \$100 of sales. The costs of doing business, while large in the aggregate, are small when expressed in percentage, much smaller than the percentage which commission merchants usually claim as necessary for the same service. Many times has Mr. J. P. Murphy, the organizer, as well as the managers of the other member creameries, stated that without the Challenge Cream and Butter Association, their creameries would have been compelled to close down years ago. If asked on what the success of this business mostly depended, we would unhesitatingly say, on loyal cooperation of our directors and dairymen, on high quality, and on prompt and courteous service.

Such is the story of the cooperative marketing of butter on the Pacific coast. Four attempts met with failure, one attempt is still on trial. In keeping with the prevailing sentiment all over the world for conducting business cooperatively, the cooperative marketing of butter on the Pacific coast must grow. But in order to justify its existence, cooperative marketing must improve the quality and

promote the uniformity of the products handled, it must operate with great economy and efficiency, and if it is going to make the greatest success it must save the consumer some money as well as the producer.

Chairman MILLER. Mr. Macklin is not present to read his paper. The next speaker is V. D. Chappell, associate professor of dairy manufactures, Oregon Agricultural College, who will speak on "Building a cheese industry in new territory."

BUILDING A CHEESE INDUSTRY IN NEW TERRITORY.

VINCENT DICK CHAPPELL, associate professor of dairy manufactures, Oregon Agricultural College, Corvallis, Oregon.

The marketing of cheese from Tillamook County, Ore., has met with such outstanding success that a general statement with reference to conditions that have contributed to the successful manufacture and marketing of cheese from this locality should be of interest. It must be remembered that the marketing of Tillamook cheese has been closely associated with its manufacture.

GENERAL CONDITIONS IN TILLAMOOK COUNTY.

One important reason why Tillamook County has attained such an enviable reputation as a producer of good cheese is because of natural conditions, the climate and soil and geographical location. Tillamook County is located in the northwest part of Oregon. It has about 60 miles of seacoast washed by the warm Japan ocean current. It is separated from the Willamette Valley by the Coast Range of mountains. The climate is mild. The mean annual temperature is 50.5° F. with an average daily range in temperature of less than 13° F. During the last 10 years the highest temperature recorded was 98°. This was reached only twice during this period, and during the same period the lowest recorded temperature was 10° above zero, and this temperature was reached only once. With such moderate temperature the year round and an average yearly rainfall of 115 inches, Tillamook County is favored with a luxuriant growth of natural grass that remains green every day of the year. Instances have been known where 12 cows have been supported on 18 acres. These cows were pastured on 10 acres until late September and during this time 3 tons of hay were cut from this pasture.

The population of Tillamook County is 8,810. As is generally the case in dairy sections, the people of Tillamook County are progressive. The dairymen point with pride to the wonderful success that they have made. The cooperative spirit is so strong that competition has never attempted to enter the county since the organization of the Tillamook County Creamery Association, in 1909. Since that time, and without much intentional effort, there has been a process of elimination going on that has spelled failure to every privately owned creamery or cheese factory that attempted to operate in the county.

When one considers the size of the county and the amount of cheese made, it is interesting to know that not over 13 per cent of the

county is improved. Of the 720,000 acres in the county, only 91,827 acres are in farms, 40,294 acres of which are covered with timber which eventually will be cleared. Every farmer makes a practice of clearing a few acres every year so that the amount of tillable soil has been on the increase. Seventy-eight and four-tenths per cent, or 625, of the 797 farms in the county are farmed by their owners, of which 211 are foreigners. The average number of acres per farm is 115.2 with 33.5 acres improved. There are approximately 14,000 dairy cows in the county. Under ordinary conditions 2 acres will easily support one cow, although it is a common occurrence to find one cow for $1\frac{1}{2}$ acres. It is considered good practice to feed grain the year round. As it is necessary to make the best of what pasture they have, it is quite common to find farmers dividing their fields, which they pasture alternately. When one field has been pastured off and the cows taken to another pasture, this field is immediately given a good sprinkling of liquid manure. This practice is followed as far as possible over the whole farm. Pasturing is not recommended under normal conditions from December 1 to March 15, due to the fact that this is the rainy season. During this time the cows produce better if fed under shelter.

A very decided improvement in conditions in general was made between 1902 and 1910. The value of farm property in 1900 was valued at \$2,093,000, while in 1910 the same property was valued at \$7,721,000. Farm land alone increased in assessed valuation from \$1,339,000 to \$6,424,000 during that period. This great increase was due chiefly to the fact that during this period the Tillamook County Creamery Association became firmly established. This created a steady market for the cheese.

Even though Tillamook County has an abundance of grass the year round, as a dairy section it is handicapped by the damp, foggy climatic conditions which prevent ripening of grains. No cereals whatever are matured in the county. Hay and forage crops estimated at 68,420 tons are produced annually, which constitute, along with some fruits and vegetables, all the feed that is raised in the county. It is necessary, therefore, to buy large quantities of grain and hay from the outside. The purchase of a very large part of the feeds used in the county is handled through the secretary of the association. He operates a warehouse and feed mill, buying feeds at the best price possible and selling to the farmers at a very small margin.

PIONEER CONDITIONS.

During the pioneer days of Tillamook County, butter only was made. This was packed in kegs or tubs and shipped in schooners to market, there being no railroad connecting the county with the outside until 1911. This proved very unsatisfactory. Shipping facilities were very uncertain. Butter was so long in getting to the market that it deteriorated much in quality, and the returns were very small. This necessitated such delay in returns that dairying was not encouraged. The factories were then constructed to make both butter and cheese. The condition of the market determined which was made. As it was necessary to hold cheese several weeks before marketing, and as there was less danger through deterioration in transit,

the manufacture of cheese gradually gained in favor. Weather conditions had much to do with the change from butter to cheese. Summer dairying was natural, due to the abundance of green grass at that time of year, and the high cost of shipping feed during the winter.

THE FIRST STEP TOWARD ORGANIZATION.

The real development of the cheese industry in Tillamook began in the latter part of 1902, when Mr. Carl Haberlach took up the work as secretary of the Tillamook creamery. At that time there were 40 factories in the county, 4 cooperative, 16 privately owned, and 20 operated by farmers handling their own milk and perhaps the milk of two or three neighbors. In 1913 this number had been cut to 22, all cooperatively owned but 2. One of these made cheese on a commission basis, and the other was privately owned. In the early days butter and cheese were consigned to dealers who would play one factory against another and bear the price downward.

In 1904, Mr. Haberlach began acting as secretary of the Cloverleaf creamery in addition to the Tillamook creamery, and, having control of the make of two large factories, he had sufficient volume to sell the product at an advantage. In 1905, he was acting as secretary for five factories. This gave him such a large volume of cheese to sell that he was practically able to establish the price paid for all Tillamook cheese. During this time, he was merely acting as an employee of each of these factories as an independent agent. The factories were not affiliated. The prosperity of the cheese industry in Tillamook County really dates from this time. In the latter part of 1905, one company operating seven privately owned factories failed, and the next year several went into bankruptcy and others were sold to farmers to be operated as cooperative factories.

THE ORGANIZATION OF THE CREAMERY ASSOCIATION.

During the spring of 1909, when Mr. Haberlach was selling for 16 commercial factories and two farmer factories, many complaints were received objecting to the variation in quality. This immediately indicated serious marketing difficulties unless immediate attention was given to uniform quality. To remedy this situation the Tillamook County Creamery Association was organized. This is an affiliation of the various cooperatively owned factories. A cheese inspector was then employed for nine of the largest factories. F. W. Christensen was considered the man best qualified for the position as inspector. In 1913, he was inspector for 16 factories, making a trip to each factory every week, and scoring cheese from each vat of milk. This inspection service increased the yield from 10.7 pounds per 100 pounds of milk in 1909 to 11.2 pounds in 1912. This alone netted \$15,236 in one year, or more than enough to pay for all the inspection and selling expense, to say nothing of the improvement in quality. Mr. Christensen, after 14 years of service, is still acting as inspector, and visits each of the 25 factories each week. The inspector makes a daily report showing factories inspected, pounds of cheese on hand, and its quality. This gives the salesman accurate information as to quality or grades, the amount of cheese on hand for sale at all times; and by

keeping informed on market conditions, he can hold or unload as his good judgment indicates is desirable.

INSPECTION AND GRADING.

Before the inspector leaves the factory he stamps enough cheese boxes "Inspected by Tillamook County Creamery Association" to hold all first-grade cheese on hand. On the rind of each cheese going into these boxes is stamped the word "Tillamook." This word is placed in such a way as to appear on each pound of cheese sold. The second-grade cheese is then shipped in plain boxes. Each cheese maker makes a duplicate daily report of his operations. One copy is sent to the secretary of the association and the other is held at the factory. These reports show milk receipts and number and style of cheese made. When cheese marketing was placed on a sound basis, creameries could not compete with cheese factories. With the exception of a small amount of whey butter made for patrons, there has been no butter made in a commercial factory in Tillamook County since 1907.

The association does not have a central warehouse for receiving all cheese. Most of the cheese is prepared for shipment at the factory where made, but occasionally some is assembled at a convenient shipping point and consigned from there. The experience of previous years is used in regulating the shipments and planning the distribution of the cheese. In the early days of the association it was the custom to ship all cheese to Portland and allow jobbers to reship from there. This was expensive. The method had nothing to recommend it, and it was, therefore, discontinued for the plan of direct shipment which is now practiced.

STORAGE AND DISTRIBUTION.

To avoid flooding the market, cheese is held in storage in Tillamook and elsewhere, especially during the flush of production. This helps to hold the market steady and eliminates many price changes. During the year of 1922 there was only 1 drop in price, while the Wisconsin market shows 13. This was made possible by placing the surplus cheese in storage instead of putting it on the market and thereby forcing a drop in price. There are about two or three times during the year when this is necessary, which cover the various months from June to December. The association had this movement in mind for a long time, but lack of funds prevented its being put into operation until recent years. A sinking fund was created which takes care of the money tied up in the cheese that is in storage. Through this method it has been possible to hold the price with only 1 decline for a period of 22 months, and during this time, under the Wisconsin method of marketing, there had been over 30 declines.

Climatic conditions are a big factor in controlling the Tillamook market. It happens that the southern California storage season begins about the opening of the Tillamook flush, and as that market becomes supplied the northern markets are entered. This keeps the distribution equalized between the different markets. The demand in the winter is ordinarily greater than the supply. Tillamook is

centrally located on the Pacific coast. As the association can ship in large or small quantities at any time, it can, within limits, control the supply and prevent a surplus from accumulating on any given market. Practically all the sales are handled in pool or car shipments. This saves considerable freight and gives best service.

EFFECT OF EASTERN CHEESE ON PACIFIC COAST MARKET.

The price of cheese on the Pacific coast is controlled by shipments from Wisconsin and New York. Therefore, Tillamook cheese sells for Wisconsin and New York prices, plus freight and less freight, from Tillamook to the market. This factor has much to do with the high average price of Tillamook cheese as compared with the eastern cheese. Tillamook cheese is so thoroughly advertised in the West that the consumer does not just ask for cheese, but asks for "Tillamook" cheese.

Inasmuch as Tillamook is a producers' market, and as eastern cheese has always been shipped West in very large quantities, much effort has been made to keep prices low enough so that extremely large shipments of the eastern cheese would not be started West to break the Pacific coast cheese market. Experience has shown that if a market is held up temporarily, and higher prices are received than conditions justify, much cheese will eventually come West and cause a reduction of price. As a result, a much lower price would be obtained later in the season than would normally have been the case. The association keeps in very close touch with the eastern conditions, and is thoroughly informed at all times as to the production and amount in storage on the eastern markets. The policy of the Tillamook association in keeping in close touch with market conditions in general has placed it in a position to establish a steady and definite price. All quotations are made f. o. b. Tillamook. Buyers know that when Tillamook cheese is quoted at 30 cents, that 30 cents is the lowest price for which Tillamook cheese may be purchased, regardless of his location or the quantity he wishes to buy.

WHERE THE CHEESE IS SOLD.

The cheese markets for Tillamook cheese follow in order of importance: Los Angeles, Calif.; San Francisco, Calif.; Portland, Oreg.; Seattle, Wash.; Tacoma, Wash.; Spokane, Wash. With the exception of Portland, the association has a broker in each of the above cities who handles the cheese on a commission. The broker keeps the association informed as to the general conditions of the cheese market in his locality, and the broker in turn is instructed by the association. Sales by brokers are controlled by the association. With information coming in from the markets at regular intervals, the association salesman is kept in very close touch with market conditions and is in a position to make quick decisions and act accordingly.

Inasmuch as all cheese orders are handled by the association direct, no report is made public of the amount of Tillamook cheese on hand at any time. There is no tendency for the cheese market to fluctuate because of misleading reports of surplus cheese, as is the case with

butter. Since there is no broker handling Tillamook cheese on the Portland market, orders from jobbers on this market are handled direct by telephone. In this way the association saves the one-fourth cent per pound commission.

HOW DEMAND IS MAINTAINED.

No price is quoted on second-grade cheese. The system is so perfected that less than one-half per cent of the total make is classed as "seconds." These are easily marketed in isolated sections, such as logging camps, etc. The home market will prefer the home product, and as the first-grade cheese is scored fine, good, or fair, any cheese scoring fair can easily be marketed with the Oregon trade. For



FIG. 1.—Comparative cheese prices, Wisconsin and Tillamook.

instance, some markets demand a high-flavored cheese, and in this case a second may serve the purpose of a first. One of the important factors having to do with the success of this association is the lack of information given to the trade on the amount of cheese on hand at any one time. The geographical location and isolation previously mentioned is a factor here. The practice of always keeping the market cleaned up before selling further orders is also important. Frequently when a large quantity of cheese is on hand and the market is weak it is withheld from the market and orders are not fully filled. No buyer is ever permitted to stock up heavily. The cheese is never unloaded or dumped. It is almost "rationed" out rather than sold. The accompanying chart shows the price changes of Tillamook and Wisconsin cheese for the year 1922. This clearly illustrates how the association has stabilized the price of the cheese it handles.

STABILITY OF PRICE.

Prices have been affected in the past by some large factory, having no idea of conditions in general, receiving some unfounded report and, without investigation, dumping its product on the market regardless of actual conditions. When smaller plants hear of a move of this nature they too are likely to unload. As Tillamook brand has gained in favor, this factor has had little effect on its sale. It has a growing tendency to replace more and more of the eastern cheese.

VOLUME OF BUSINESS TRANSACTED BY THE ASSOCIATION.

The volume of business handled by the Tillamook County Creamery Association is shown in the accompanying table. Attention is called to the uniformity of the yield of cheese per 100 pounds of milk during this period of time. This is the result of the standardization methods employed by the association.

As would be expected, there is considerable variation in the price received by the farmers for their milk over this period of time. It is equally interesting to note the favorable price received throughout this period notwithstanding the unfavorable economic conditions prevailing. These facts should be sufficient to indicate the success with which the association is serving the producers as a marketing agency. The original intent was not to form such a large organization, but with proper management it naturally has shaped itself into its present large and well-established form.

Summary of secretary's report for the last five years.

	1918	1919	1920	1921	1922
Cost of manufacture, per pound..	\$0. 02685	\$0. 03437	\$0. 04137	\$0. 04307	\$0. 04004
Received by farmers for each pound of fat.....	\$0. 644	\$0. 798	\$0. 7163	\$0. 6259	\$0. 5990
Received by farmers for each hundredweight milk.....	\$2. 66	\$3. 31	\$2. 935	\$2. 585	\$2. 48
Yield of cheese, per hundred-weight milk (pounds).....	11. 16	11. 386	11. 36	11. 21	11. 13
Yield of cheese per pound of fat (pounds).....	2. 7	2. 749	2. 757	2. 71	2. 68
Selling price of cheese per pound..	\$0. 2636	\$0. 324	\$0. 2963	\$0. 2306	\$0. 2579
Average per cent of fat in milk....	4. 13	4. 14	4. 12	4. 13	4. 14
Received from sale of whey cream.	\$19, 746. 39	\$32, 305. 12	\$33, 233. 48	\$24, 005. 58	\$30, 812. 74
Total quantity of cheese made (pounds).....	5, 036, 900	6, 091, 259	6, 436, 600	6, 722, 893	6, 615, 957
Value of cheese made.....	\$1, 352, 694. 38	\$2, 007, 500. 00	\$1, 937, 956. 15	\$1, 576, 991. 96	\$1, 741, 418. 72

MAIN REASONS FOR SUCCESS OF THE ASSOCIATION.

Very often we hear the question, "Just why has Tillamook been so successful?" The following facts are important. The leadership of Mr. Haberlach is the chief factor. He has a very intimate knowledge of all market quotations and very accurate information with reference to market conditions in general, received from over 20 years of experience.

The inspection of the cheese made weekly is a second important factor. The inspector is in close contact with the cheese makers at all times. This inspector has been connected with the association

ever since its organization and has trained practically every cheese maker now making cheese in the 25 association factories.

During the winter of 1918 the cheese makers of the county organized the Tillamook County Cheese Makers' Association. This association has brought about the adoption of a salary scale for every factory. The scale is determined by amount of milk handled, conveniences in the factory, etc. In case of a vacancy at any time the association recommends one of its members, and in this way accomplishes a good service to both parties. All members attend monthly meetings, where they have an opportunity to rub elbows with each other and discuss their difficulties. This keeps them in constant readiness to meet any manufacturing difficulty that may arise. Scoring contests are held in connection with these meetings, and the cause of certain defects in the flavor or workmanship are explained. In case a factory has any manufacturing difficulties at any time during the month, the cheese from that day's make is entered at the monthly scoring contest for study.

The county employs a milk inspector who is a deputy dairy and food commissioner. He inspects every farm in the county at least once a year, and more often if possible. He works in close touch with the cheese inspector, and when the inspector finds difficulty at any plant that appears to come from the farm the dairy inspector immediately cooperates. Every cheese maker is instructed to reject all milk that is in any way off flavor. The dairymen have been informed as to the effects of poor milk on the quality of the cheese and take considerable pride in delivering the best milk possible. As the cheese makers know that they are backed by both the milk and cheese inspector, they inspect every can of milk very closely and never hesitate to reject a can no matter how large a shipper that patron may be. This independent attitude has been a big factor in production of clean milk.

The county also employs a veterinarian to inspect all cattle for tuberculosis. A complete test is made on every herd each year. Tuberculosis has been practically eliminated from the county, and this point is used as a strong advertising feature.

ADVERTISING THE PRODUCT.

The Tillamook County Creamery Association has realized for many years that it has very keen competition to meet, and as the production has increased this factor has become increasingly important. When Tillamook cheese first came on the market a demand for eastern cheese had already been established. It was therefore necessary for Tillamook to make a place for itself on the market. This was easily accomplished with the trade in Oregon. The increase in the volume of production demanded an outside market, and this has increased until now over 65 per cent of the 1922 make of 6,615,957 pounds of cheese were sold in California at 6½ cents above Wisconsin quotation. It is plainly evident that the Tillamook brand is very successfully competing with all other brands. As the selling price of the Tillamook cheese averaged 6½ cents above Wisconsin for the whole year of 1922, it is readily indicated that the Pacific coast trade demands Tillamook cheese. The combined population

of Washington, Oregon, and California is 5,613,482. With the per capita consumption of 3.8 pounds of cheese as a basis, Tillamook County produces 32.2 per cent of the cheese consumed on the Pacific coast. To increase demand for Tillamook cheese, an advertising campaign has been started. This is financed by a fund created through an assessment of four-tenths of 1 cent per pound of cheese. This campaign has been carried on by placing large advertisements in practically all papers published in large cities on the Pacific coast. The advertisements have emphasized the food value as well as the fact that the cheese is made from a milk free from tuberculosis, that every cheese is given very thorough inspection and is made under the most sanitary conditions.

In 1917 the plan was adopted to place the word "Tillamook" on the edge of every commercial grade cheese so that the name would be on every pound sold. This gave rise to the advertising slogan "Look for Tillamook on the rind." Their advertising material has also given many recipes using cheese and showing how cheese may be substituted for other foods on the menu. A very artistically decorated poster has been prepared for retail stores where Tillamook cheese is sold and a few illustrated billboards have been placed in some of the larger Pacific coast cities.

Chairman MILLER. We have had some very interesting papers on the marketing of butter and cheese. Our next paper will have to do with the manufacturing and marketing of condensed milk and will be presented by Mr. J. A. Scollard.

COOPERATIVE MANUFACTURING AND MARKETING OF DAIRY PRODUCTS.

J. A. SCOLLARD, president, United Dairy Association of Washington, Seattle, Wash.

To appreciate fully the changes which the advent of cooperative marketing has wrought in the State of Washington, you must first be made acquainted with the condition which prevailed prior to the entry of these associations into this field. Prior to the organization of the United Dairy Association of Washington and its member units, approximately 50 per cent of the milk produced in that State found its way into cans in the form of evaporated milk. When it is understood that the percentage of the total milk produced in the United States in canned milk has never reached 5 per cent of the total production, and when you take into consideration the fact that in the process of evaporation, the finished product is approximately 50 per cent of the weight of the raw material, the significance of these two facts will immediately impress you. In addition, when you know that but a comparatively small percentage of this canned milk was consumed in local territory and the balance bore a heavy freight rate to the consuming centers of the East and Middle West, you will grasp the fundamental reasons for the formation of these cooperative associations and the necessity that existed for the introduction of a more flexible system.

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It should be also borne in mind that a practical monopoly was held by one of the large corporations in the districts of heavy milk production, and that the eight plants which this company had established were built and equipped solely for the purpose of canning milk, under a rigid system, with no facilities for turning the raw material into other products when the market for canned milk was unduly depressed, or when the outlet for it was completely closed. I might say here that canned milk is, perhaps, the most erratic of all dairy products; generally, it is a feast or a famine with the manufacturer of this product, and certainly it is the least dependable product from the standpoint of the producer, who must needs have something in the nature of a steady, stable market for his product, which is, as you know, one of daily production. If there is anything worse than putting all of your eggs in one basket, it is to allow another to put them all in one basket and thus carry them for you.

By way of further illustrating the disadvantage of marketing surplus milk in canned form, as against other dairy products, when the canned article must take freight shipment, I need only point to the fact that a case of milk ready for shipment, representing 100 pounds of whole milk, weighs approximately 65 pounds; that cheese from 100 pounds of milk weighs not to exceed 11 pounds; that butter from 100 pounds of milk (average test) would weigh less than 5 pounds, and that the weight of dry or powdered skim milk from 100 pounds would average about $8\frac{1}{2}$ pounds. With these comparisons in mind, you will conclude, as we did, that, since we were producing more canned milk than could be consumed in our local territory, and at the same time were importing butter, cheese, and other more highly concentrated dairy products, the situation was badly in need of adjustment.

So long as the dairymen were satisfied to supply condensers at the price which the latter were willing to fix, the situation of the manufacturers was quite satisfactory, for, by quoting a lower price in our State (Washington) than was paid by the company's plants in the Middle West and East, the western Washington producer could be made, and was made to absorb freight and other attendant charges, and thus this wrongful economic situation was being perpetuated.

It was the knowledge of these conditions, and the apparent unwillingness on the part of the corporation which held the field to cooperate with the producing dairymen in working out a solution, which resulted in the determination on the part of the latter to form an organization on cooperative lines to cope with the situation. This determination was reached a little over four years ago, for at that time the first move was made to establish associations in every heavy milk-producing district of the State of Washington. After studying the organization plans of a number of dairymen's cooperative associations, in various parts of the United States, we decided to organize along lines somewhat similar to the California dairymen's associations, but with certain departures from their plans which had been found impractical by them. We also profited in our organization plans by the mistakes made by certain other associations.

Our association, as it now exists, consists of six county or district associations. These associations have a strong contract with each

dairyman member by which he agrees to sell all his milk or cream through the association, the association agreeing to find the best possible market for his products. The county association has in turn a contract with the United Dairy Association of Washington, the central organization, making the latter its sales agent for all of its surplus finished product. This contract also permits the United Dairy Association of Washington to prescribe the selling territory of the county association, and to have complete supervision of its plants for the purpose of standardizing the whole output from all of the factories. The central association, therefore, has virtual control of the county units by reason of this contract with them.

The county associations are all organized on a nonprofit basis, capital stock varying according to the number of cows in the respective districts, but always on the basis of one share of stock for each cow owned by the member, at \$10 a share. Each member is entitled to one vote only, regardless of the amount of stock held by him.

After the canvass for membership was concluded in all of the the purpose of standardizing the whole output from all of the factory in each county to take care of the milk of the association members in that district. At the present time we have 6,500 members within our associations. After numerous conferences, in which representatives from all the county associations participated, an acceptable construction program was outlined. Most of the plants under this program were built so as to permit the manufacture of any one of several dairy products, as the demand for them seemed to warrant. These plants have been referred to as utility plants.

At this time we have 10 plants in operation, with an approximate valuation of \$1,750,000. The capital stock of the associations was entirely inadequate, on the basis of \$10 per cow, to finance the building of these plants, and first-mortgage bonds were issued in amounts necessary to cover the additional cost of constructing and properly equipping them. These bonds were sold almost entirely to dairymen members of the associations. Of the 10 plants now in operation, 7 of them are plants of large capacity, and 3 are minor plants, but capable of handling, in the aggregate, a considerable quantity of raw product. The 7 large plants have a combined normal capacity of 800,000 pounds of whole milk daily, but are capable of handling, and have handled, upward of 1,000,000 pounds per day during the peak of the surplus period. These plants are modern and efficient, and, with the exception of one acquired by purchase, are newly constructed. Three of the plants are built for the purpose of canning evaporated milk; three of them are equipped for the manufacture of butter, cheese, and milk powder; four of them are in such proximity to each other that milk can be diverted from the members' farms either to a condensery or utility plant, as the market conditions for the various commodities seem to justify.

We are thus enabled to maintain a distinct flexibility in connection with our operations. The flexibility is further maintained within the utility plants where the relative quantity of butter and cheese can be increased or decreased to a considerable degree with the powder plants available for handling skim in greater or lesser quantity, depending upon the other products manufactured. Of the three

smaller plants, above referred to, two are cheese factories and one a milk-distributing depot and small dairy products factory.

It is not necessary to give the locations of our 10 plants. It is sufficient to state that they are located in the heaviest milk-producing sections of our State. All of our plants, with one exception, are of tile construction, and were equipped with the most modern and efficient appliances to be had at the time of their establishment. Practically all of the raw product arriving at these plants comes in the form of whole milk. The first process, after weighing, sampling, and testing, is the process of skimming, from which our sweet cream goes direct from the separators to the butter department, and the skimmed milk to the vacuum pans and on to the drying department. Practically our entire output of butter is manufactured from cream freshly skimmed from whole milk. The greater portion of our butter output is packed in 68-pound cubes. This butter has created for itself a special classification among buyers—"Whole-milk extras." We are not aware that this designation has been used before. The quantity of this uniform, high-quality butter, made under our system, reaches as high as 30,000 pounds daily, and the average daily production throughout the year is about 20,000 pounds. Our main outlet for this butter is through the Seattle and Los Angeles markets. The price of this butter in cubes is maintained at a quotation of 3 cents under the wholesale price of pound prints, f. o. b. Seattle, while the price of good creamery offerings usually fluctuates between 4 and 7 cents under the wholesale print quotations. Our ability to supply quality butter in any reasonable quantity enables us to maintain this narrow spread.

Last year we manufactured approximately 650,000 cases of unsweetened evaporated milk. This year our output will exceed 750,000 cases. Our canned milk is sold in Washington, Oregon, and parts of California direct to the retailer. In eastern Washington, Montana, and Idaho it is sold through jobbers, although we maintain salesmen in these territories to stimulate business.

Our chief brands, all owned by the central organization, are "Darigold," "Federal," and "Cooperative" brands. We control several other brands, but make infrequent use of them. The "Federal" and "Cooperative" labels are used only on canned milk, the "Darigold" label being used on all the products turned out by us. We also pack some milk under buyer's label, but the combined sales in this way will hardly reach 100,000 cases annually.

We have established a remarkable record for quality, which shows itself in the fact that in the first 1,000,000 cases of milk manufactured by our association and sold within a two-year period, we have been called upon to make adjustments on but 15 cases of milk, and this in an instance where storage had been lengthy and the storage conditions poor.

We are spending only a moderate amount of money in advertising; our total expenditures for this purpose for one year have not reached \$25,000.

The United Dairy Association of Washington is made up of one representative from each of the county associations. Its nominal capital stock is \$100, made up of 20 shares at \$5 per share. This association had no money at the completion of the construction

program with which to undertake the marketing of such a large quantity of product in a manner that would admit of payment to the producer for his milk or cream on a monthly basis. The directors realized that to open up markets and successfully dispose of the large output of the association plants would require men of experience as well as considerable capital. Therefore, they caused to be formed the Consolidated Dairy Products Co. This company has a paid-up capital of \$300,000 and was organized for the sole purpose of selling the association's products. The basis of its formation was a contract with the United Dairy Association of Washington whereby the latter was to sell through it the association's products not disposed of locally. A rigid investigation of the selling costs of various dairy products was made by the United Dairy Association of Washington, and the commission on sales by the Consolidated Dairy Products Co. was based on the results of this selling cost investigation.

The contract between the United Dairy Association of Washington and the Consolidated Dairy Products Co. was made for one year, with the privilege of renewal, and contains three salient features which fully protect the association: First, the contract can be terminated by either party on 60 days' notice, and, in the event of its termination, the association has the option of buying at cost less depreciation the distributing machinery of the Consolidated Dairy Products Co. Second, the association fixes the selling price of all products sold. Third, commissions, as fixed by the contract, are subject to revision whenever it becomes apparent that they are out of line with actual selling cost and a fair profit. The contract further provides that the United Dairy Association of Washington shall have one of its members on the board of directors of the Consolidated Dairy Products Co., with access to all records; a monthly statement of all sales and transactions is rendered the association, and a complete audit is made every six months.

Each factory has at least one competent field man who "shoots trouble" in running down low-quality milk and cream shipments, and whose constant aim is to improve the conditions of barns, premises, etc. Our whole force also works closely with the State inspection service in building up the quality of the raw product. Sediment tests are frequently taken and the discs pasted on cardboard, according to route. The field man then visits the patrons on that particular route, showing the chief offenders of sanitary decency what their discs look like in comparison with the others, but not neglecting to show the high-score men their discs, with the proper commendation for them upon the quality of their product. Our chief argument with neglectful shippers is that their interest in the product does not cease at the receiving platform, as it does at privately owned plants, and that their chance for high returns lies in our ability to attain quality in the finished product, which can not be done with poor raw material. We have, of course, the advantage of having the backing of the offender's neighbor members, who are also interested in seeing an improvement in the quality of the shipments because of its effect upon their price return as comembers. Pride and rivalry are thus excited, and the results are usually

favorable. The State inspection department has declared that we have improved the quality of the raw milk and cream, in the districts in which we operate, 30 per cent over its condition prior to our entry into the manufacturing field.

Our milk-powder plants do not manufacture whole milk powder, except for specific orders, but are engaged almost exclusively in skimmed milk drying. Our plants employ the so-called spray process in drying chambers after condensation in ordinary vacuum pans has reduced the moisture to the required degree. Our total output of skimmed-milk powder will reach approximately 6,000,000 pounds in 1923. We are the third, if not the second, largest producers of this commodity in the United States, our output being approximately one-seventh of the total output in this country. A very large bulk of our powder is packed in barrels containing 220 pounds net. The bakery trade, ice-cream manufacturers, and confectioners are the largest users of this product. Our powder reaches practically every part of the United States, in large or small lots. Our sales, except for local sales, are in carload lots to buyers in direct touch with concerns in the above-mentioned trades. In 1922 we made a sale to one such concern of 50 carloads, aggregating 3,000,000 pounds of skimmed-milk powder. We make sale direct to users in coast territory. We also pack some quantity in 1 to 5 pound tins for retailers, but this quantity is negligible. For our own oriental business, we have a very active sales connection in Japan. This concern makes a repack of our barrel milk-powder shipments in tins of varying sizes for resale in oriental countries, under our Darigold label. Our Japanese friends are extensive advertisers on their own account. They report that they have 2,000 agencies (they must necessarily be small) scattered throughout Japan. At any rate, they are developing a growing and satisfactory business.

In 1922 our sales through the central organization reached approximately \$4,500,000. The sales this year through this agency will exceed \$6,000,000, and our total sales, including local sales made by individual associations, in their own territory, together with the sale of fluid milk made by one or two of our member associations, will exceed \$10,000,000 gross. Our cost of sales through the Consolidated Dairy Products Co. will, for the year, be less than $3\frac{1}{2}$ cents upon the dollar of sale.

In summing up the operations of the United Dairy Association of Washington, from the time of the establishment of its plants, I believe we can say with modesty that we have attained success. We have, since the establishment of these plants, operated every factory full time, without a break, including Sundays and holidays. We have met every pay roll for labor or milk with full payment on the regularly designated pay days; we have successfully marketed and collected for the large and varied output of all our factories, developing local, eastern, and foreign markets for Darigold products. Through standardization and efficient handling of products we have established a record for quality of butter, cheese, evaporated milk, and milk powder unexcelled by our oldest and largest competitors. We have fully met every interest obligation on our bonds when due, and have retired a considerable portion of our bond issues. These bonds have 100 per cent value in their districts, and in some in-

stances they command a premium over par. Our membership has increased by over 10 per cent since January 1, 1923; and by way of illustrating the price advantages which the operations of the association have obtained over conditions which formerly prevailed, I wish to quote the average price paid by the largest country buyer in Washington during the years 1913, 1914, 1915, and 1916, which is generally referred to as the pre-war period. This price was \$1.53 per 100 pounds for 3.8 per cent milk. Our plants were established in 1921: The average price paid by our plants for 1921, 1922, and up to and including July, 1923, has been \$2.03 per 100 pounds for 3.8 per cent milk. This is an increase of approximately 33½ per cent over the pre-war period above referred to. Since quality betterment and price betterment are the ultimate aims of cooperative marketing associations, I believe I may reiterate the statement that we have been successful.

Chairman MILLER. This, ladies and gentlemen, will complete the program as far as time will permit. The remaining papers that have not been given will be read by title and will be published in the proceedings of the congress. May I express for you our appreciation to the management of the theater for their courtesy in extending to us the use of this theater.

(Adjournment.)

(Papers read by title):

SYSTEMS OF DAIRY FARMING IN SCOTLAND AND THE DEVELOPMENT OF COOPERATIVE ORGANIZATION IN DAIRYING.

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During the nineteenth century and, to a certain extent, until the early years of the twentieth century, dairy farming and the business of milk production in Scotland were conducted under several distinctly different systems. The system adopted in different localities was determined chiefly by local conditions and proximity, or otherwise, to the more populous centers.

At one time the large centers of population were supplied with milk produced, for the most part, from cows kept in town dairies. These cows were usually stall fed; that is, they received the whole of their food in the byres or cowsheds where they were stalled. The bulk of the foodstuffs was obtained from suburban farms, supplemented with the by-products, in the shape of draff and dreg, obtained from the local breweries and distilleries, and other concentrated foods. In many respects it was a wasteful, uneconomic system, and especially wasteful of cow life, inasmuch as the young cows, usually bought when in their prime, for the most part of the north of England nonpedigree milking Shorthorn type, were kept only one season; or, strictly speaking, only as long as they yielded a profitable return, and they were then sold to the butcher, and the empty stalls were filled by newly calved cows. Generally speaking, there was a wide margin of reduction between the inbuying price of

the newly calved cows, and the outgoing price when sold to the butcher.

So long as the majority of milk consumers were prejudiced in favor of warm milk freshly drawn from the cows, this system largely prevailed. With the introduction of stricter sanitary regulations bearing on cowsheds in towns, the more scientific method of treating milk, by which it can be carried long distances in a wholesome condition, and the better means of transport, large and ever-increasing quantities of milk are now being brought in from rural districts, and the system of keeping cows in town dairies is being very largely supplanted.

Another factor which no doubt contributed to this result was the serious outbreak of rinderpest, which devastated Scottish herds of cattle in 1865 and wiped out many of the city and town dairy stocks; the recurring outbreaks of foot-and-mouth disease, which led to the compulsory slaughter of many valuable herds, also influenced the situation. With the town supplies so disorganized, milk had to be found, and supplies were gradually drawn from an ever-widening zone in the rural districts.

BUTTER MAKING.

Butter making on the farms situated a few miles from the towns was largely followed at one time, especially in the west of Scotland, and on a greatly limited scale is still practiced in certain districts. The butter was made from lapped or ripened whole milk, and twice a week, or oftener as the demand necessitated, the butter and the buttermilk were distributed direct to the consumer from milk carts sent in from the farms. Under this system butter of excellent quality was produced.

With a greatly increased population in the towns, there has sprung up a greater demand for fresh milk. Home baking is now less practiced, and the demand for buttermilk has consequently fallen off. The importation of butter in large quantity of excellent quality from the ends of the earth, together with the greatly increased production of butter substitutes, has rendered butter making on the farm a less profitable proposition, and the system just described has for the past 15 years been decisively on the wane.

CHEESE MAKING.

Cheese making was very largely practiced 20 years ago on the farms in the upland districts of the central counties and in the west and southwestern counties, and is still an important industry in some parts of the counties of Lanark, Ayr, Wigtown, and Kirkcudbright. Where this system of dairy farming was adopted it was the usual practice to arrange, as far as possible, to have the cows calving during the months of March and April. It is not usual to start cheese making till the cows are turned out to pasture early in May, and the milk produced till then is usually sold to city milk distributors. The milk is similarly disposed of toward the end of October when cheese making stops. When the market is bare of cheese—as sometimes happens, notably this spring—and when there is consequently

a good demand, it is not unusual to make cheese in the early spring months while the cows are still on house keep. Cheese made under these conditions are termed "fodder" cheese and are not of such high-class quality, and do not possess such good keeping properties as the product made when the cows are out on pasture. They have to be disposed of quickly, and are not subject to the shrinkage in weight which occurs in the case of summer-made cheese, well ripened and matured. Under favorable market conditions it is found sometimes more profitable to make "fodder" cheese than to dispose of the milk on an oversupplied market, as it is apt to be with so many cows calving on the cheese farms in the spring months.

Pig feeding is a necessary adjunct of the cheese-making farm. It is generally computed that the return obtained for utilizing the by-product of whey in fattening pigs should pay the working expenses of the dairy.

Toward the close of the nineteenth century, a few creameries or dairy factories on a proprietary basis were established in the milk-producing districts in the southwest of Scotland and two or three other centers, and to these establishments large quantities of milk, formerly made into cheese during the summer months, were disposed of. The system of manufacture adopted at these factories was, for the most part, butter making, and, at a later stage, the manufacture of margarine was taken up. Several of them continue to do a large and successful business, but in a few instances in recent years the business has been taken over by farmers' cooperative dairy associations and conducted as milk-collecting depots and cheese factories.

COOPERATIVE DAIRYING.

It was not till the year 1905 that a serious attempt was made to promote cooperative organization amongst Scottish farmers. In 1904 a delegation of representative Scottish farmers visited Denmark in order to inquire into the system of organized cooperation which had proved such a success in that country.

On their return, a report giving their impressions of what they had seen, and to what extent similar schemes could be adopted to suit Scottish conditions, was published and widely circulated. The writer, who was then dairy farming on an extensive scale, was a member of that delegation. Shortly thereafter the Scottish Agricultural Organization Society Ltd. was brought into being. That society was formed for the purpose of developing the cooperative organization of trading operations connected with farming. It is a purely educational and propagandist society, designed to promote the formation of local cooperative associations for agricultural trading, and to further the work of such associations. It is not itself a trading body and does not engage in commercial transactions.

It is now generally recognized that the principles and methods advocated by the organization society are of the utmost importance in the development of agriculture and the improvement of rural life.

The society in its early years was financed from a fund subscribed by public-spirited landowners and the larger tenant farmers, and latterly it has relied for financial support in carrying on its work

on the annual subscriptions of individual members and affiliated societies, supplemented by grants from public funds.

Shortly after its formation, the society, amongst other work, took up the question of promoting schemes of cooperation amongst dairy farmers. A special committee was appointed, consisting of gentlemen who had given special attention to this question, and who had had an opportunity of studying cooperative methods in European countries. Just as had been done in promoting cooperative schemes for other branches of the agricultural industry, it was felt that a start should be made in those districts where the need of organization was greatest.

A suitable field was found in an upland district 15 or 20 miles from the city of Glasgow. The farms were relatively small, and the production and sale of milk provided the main source of revenue out of which rent and other charges had to be found.

The general practice was for the farmers in that area to sell their milk on a yearly contract to Glasgow milk distributors. It was, however, a case of the individual dairy farmers attempting to negotiate at great disadvantage with members of a well-organized trade association. In this particular district the farms were not suitably equipped with buildings in which the manufacture and storage of cheese could be conducted. The farmers had, therefore, no alternative method of disposing of their milk and were consequently in a measure at the mercy of the middlemen dealers.

The price received for milk was an exceedingly unremunerative one, so much so that it seldom left a margin out of which the farmers' wives and families could get any reasonable remuneration for their labor. The milk was conveyed to the city by rail, and it was the policy of the railway companies in these days to deal with this traffic in the early hours of the morning before the passenger traffic got busy. The trains conveying the milk left at such an early hour that the operation of milking the cows at the farms had to be carried out between the hours of 3 to 4.30 in the morning, according to the distance from the station.

The scheme evolved, after much consideration and inquiry by the committee of the organization society for such districts, provided for the building and equipment, wherever circumstances permitted, of central milk-collecting depots, preferably contiguous to a railway station, to which the milk produced on the farms within a radius of 5 to 6 miles could be sent. Provision was made for the brine cooling of the milk over refrigerating plant installed at the depots on the most up-to-date system.

A gravitation supply of spring water was a necessary part of the equipment, as well as a properly insulated cold store. The milk so treated at the depots could be sent with safety long distances by rail. The promoters were no longer tied up to a restricted market, being in a position to consign milk, not only to the principal populous centers in Scotland, but also to the industrial towns in England and to London.

In making contracts with distributors, the committee of management undertook to supply milk in quantity to suit the convenience and demand of the buyer, thus relieving the distributors of all risk of waste from oversupply during periods of slow demand, or during

holiday seasons. Each depot is provided with cheese making plant and drying rooms for maturing and storing cheese. All surplus milk not required for consumption as liquid milk is manufactured into cheese. This prevents glut and oversupply of the market, which at certain seasons tends to depress prices.

Milk products can only be successfully manufactured at the producing end, and not after the milk has been conveyed long distances by road or rail. At the city dairies the milk is usually on the point of going wrong before, as a last resort, it is manufactured into cheese or butter of inferior quality.

For these reasons the influence of the cooperative dairy associations was felt outside the areas in which they operated.

The advantage of the cooperative depot system was so apparent that farmers in other districts applied to have similar schemes promoted. In the course of a few years farmers' cooperative milk depots were formed in a number of important milk-producing districts. Under the new system milk production on the farms was conducted under less irksome conditions for the farmer, his wife, family, and employees. Excessively early milking in the morning became no longer necessary, as the combined bodies of farmers were able to arrange with the railway companies to have the milk conveyed by rail at a more suitable hour. This arrangement was facilitated by the fact that several of the societies were considering the desirability of having the milk conveyed to town by motor transport.

The farmers get their checks monthly from their own local associations. They no longer dread having to run the risk of contracting bad debts. In view of the accommodation the societies can give to the buyers in sending supplies to meet the fluctuating demands of the trade, they can pick and choose their buyers and deal only with the most reliable distributors. When contracting with individual producers, the milk distributors had to take the whole of the farmers' milk, and had to face the risk of incurring considerable loss during periods of slow demand. As a result of better organization, the producers through their associations, were able to negotiate on more equal terms with the organized milk distributors.

It has been said by one who has studied the problem closely that no force makes more strongly in the direction of education and agricultural improvement generally than does cooperation. It brings contact with a larger world which for the separate individual might well seem inaccessible. It brings new ideas and new methods. It gives the stimulus of better profit to the effort to obtain a larger production from the land. It is a great educative influence.

Cooperation on sound lines must be proceeded with step by step. The cooperative dairy associations in time discovered that it would be to their own advantage, and a great convenience to their buyers, if the milk were conveyed by motor transport to the towns instead of by rail. By this means the milk is now delivered at buyers' premises instead of, as formerly, to buyers' nearest railway stations.

For some years past milk from the cooperative milk depot in Ayrshire has been conveyed to Glasgow and to coast towns on the Clyde, distances of 20 to 30 miles. Had such a proposal been put

forward when the schemes were promoted it would have frightened the farmers, but now it is an accomplished fact.

In some cases the motor lorries belong to the associations, whilst in others they contract with motor transport companies; and this means of transport is not confined to the conveyance of milk only, as feeding stuffs are conveyed to the farms, and manures are taken from makers' works or the nearest port and conveyed to the members' farms.

It should be explained that the associations promoted to carry out these schemes are all registered under the industrial and provident societies acts, by which the liability of members is strictly limited to the amount of uncalled share capital subscribed. Each society manages its own affairs within the scope of the model rules provided for their guidance. A committee of management is elected annually by the shareholders. The societies are conducted for the mutual benefit of the members rather than for earning profits. The committee of management fixes each month the price to be advanced for the milk supplied by the members, and any profits accruing at the end of the year, after paying all working expenses, upkeep of plant, interest on capital, writing off depreciation on buildings and plants, and putting aside a sum to reserve account, are allocated to the members as a bonus, or deferred payment, in proportion to the milk supplied on which the profit was earned.

After a number of societies were in existence it was found desirable to form them into a federation with a view to regulate the trade of the various societies, avert injurious competition between them, and to take such steps as may from time to time be approved to prompt their joint action and secure their common interest.

The federation is managed by a committee elected annually and consists of four members elected by the parent body (the organization society) and two members elected by each society. The committee of the federation meets usually once a month, or as occasion necessitates. This arrangement has proved of inestimable value in promoting common action and harmonious working.

BENEFITS RESULTING FROM COOPERATION IN DAIRYING.

Prior to the promotion of the cooperative dairy schemes referred to, farmers in districts too far removed from the large centers of population to admit of the milk being delivered in time for early morning distribution were getting a very unremunerative price, averaging not more than $6\frac{1}{2}$ pence per gallon. As city distributors realized the advantage and accommodation which such associations could confer by delivering properly cooled milk instead of warm milk, as it is usually delivered by the individual producers, the price was gradually improved, and by 1914 it had been advanced 25 per cent over the 1907 prices. This increase of price was obtained by the organized farmers without necessarily (or in fact) raising the price to the consumer.

As already explained, the price in 1907 for railway conveyed milk was an average of $6\frac{1}{2}$ pence per gallon for the year, out of which railway carriage of $\frac{3}{4}$ penny per gallon had to be deducted. For the year 1913-14 the price was $8\frac{1}{2}$ pence, and for 1914-15 it had advanced to an average of 8.975 pence per gallon. Contracts

entered into in 1914 did not expire till May, 1915, consequently, during that period the price was not affected by the outbreak of war in August, 1914, though no doubt the distributors took full advantage of the position.

In 1915-16 prices advanced to an average of 11.36 pence per gallon.

During the years of war, prices were controlled and advanced to an average of fully 2 shillings per gallon. They are still maintained at a fairly remunerative level. It is, however, safe to say that but for the organization of the industry on its present footing, there would have been a danger for dairy farmers of prices falling back to prewar level.

The quantities of milk handled at the various depots average from 2,000 to 3,000 gallons each per day. The prewar cost of handling the milk at the depots worked out about three-eighths of a penny per gallon. That covered wages, coal, repairs, and replacement of plant, interest on capital, etc. During the war years the working costs were increased to an average of 1 penny to 3 half-pence per gallon, but for the past year they were back again to about 3 farthings per gallon.

But the gradual improvement in price is not the most striking advantage which has resulted from the promotion of the cooperative schemes. It has had the effect of stimulating a great increase in production.

A typical society in Ayrshire, with a membership of 30 farmers with only moderately sized farms, received a total supply of milk in 1909 of 156,177 gallons, whilst the same number of members from the same farms supplied in 1915 no less than 195,894 gallons, an increase of 39,177 gallons per annum. This result was achieved, not by keeping a larger head of stock, but by keeping milk records and eliminating unprofitable cows, and giving greater attention to the selection of stud bulls out of deep-milking cows, and breeding only from the best milking cows, and no doubt greater attention was also given to feeding and general management.

Statistics obtained from the annual reports of all the societies formed in the early years of the cooperative movement point to the same result, the increased production being put at from 25 to 30 per cent.

In the case of one society in an upland district, where milk recording had been in operation for some years, it was reported in 1915 that prior to the establishment of the cooperative milk depot many of the members did not produce milk during the winter months. The members of this society now lay their account to produce half the quantity in winter which they produce during the summer months. On an average the 24 members of this society now each produces 500 gallons more milk per annum than they did prior to the establishment of the cooperative depot.

Taking the case of five typical dairy associations, the following figures show the cash received for milk and milk products over a period of years and prove the effect which organization has had in stimulating increased production:

1910-----	£49,354	1918-----	£256,000
1913-----	82,282	1920-----	372,455
1914-----	85,025	1921-----	263,892
1915-----	190,508		

The marked increase in the years 1918 and 1920 is partly accounted for by the high prices obtained during those years, and the lower turnover in 1921 is accounted for, not by reduced production, but by the considerably lower prices obtained for milk and cheese. Widespread unemployment in 1921 caused a great drop in the consumption of milk, and more cheese had to be made.

Everyone of the associations reports that as a consequence of the working conditions on the dairy farms being less irksome, the women folks have more leisure to devote to the rearing and management of poultry, and a great stimulus has been given to that industry. More attention is also being given to the breeding and feeding of pigs.

It might be of interest to explain at this stage how the societies formed in the prewar years 1906 to 1913 were provided with the necessary capital to build and equip the milk depots. Agriculture had come through a rather bad time, partly due to a series of very unfavorable seasons and loss of crop through bad weather during harvest, but more largely due to the very low prices prevailing for farm produce. Money was none too plentiful amongst the average run of farmers, and but for the generous help of landowners the cooperative dairy schemes could not have been started at that time. A number of enlightened landlords, perceiving the advantages that the new movement would confer on their tenants, voluntarily agreed to provide the capital necessary for the building and equipment of the depots, charging a rate of interest of 4 per cent per annum on the capital expenditure.

The farmers themselves took shares in the society only to a limited extent in order to provide a little working capital. The money expended by the landlords was regarded as useful estate expenditure, as equipping a central up-to-date depot for the use of their tenants obviated expenditure in providing more modern dairy premises on the individual farms to meet the requirements of public health authorities.

After a few years' experience, when the farmers fully realized the soundness of the scheme they had embarked on, like shrewd business men they began to put aside a reserve fund out of profits, during the years of high prices, in order to buy out the interest of the landowners. The history of one is typical of the lot. One of the associations already referred to resolved a few years ago to repay the landlord's original capital expenditure, and did so entirely out of accumulated profits amounting to £2,322 odd, and this was done without calling up a single penny of additional share capital. This sum was allocated amongst the members as paid-up capital, according to the proportion due to each out of the accumulated profits.

The society purchased two motor lorries and built a new motor house and since 1913 has replaced some of the machinery entirely out of profits, after paying members the controlled price for milk during the war years, and since control ceased the price mutually agreed on between the producers' and distributors' associations. In addition, the members have been paid in bonus during the past few years a sum of £20,055.

It is a wonderful achievement when account is taken of the fact that the total paid-up capital originally subscribed by the 30 mem-

bers amounted to only £122. The sales of milk and its products by this society for 1922 amounted to £61,118 18s. 2d.

The dairy societies formed since 1914 were promoted under much less favorable conditions. The cost of building and equipment had trebled, and the farmers, unaided, found the necessary capital themselves by subscribing at the rate of one share per cow kept in stock, while any additional capital required was advanced by the members by way of loan. With that indomitable pluck characteristic of the Scottish farmer, they are rapidly overcoming the initial handicap of high costs, and all are in a sound financial position.

The committee of the federation of cooperative dairy societies has under consideration a scheme for promoting a selling agency, through which it is proposed that the sale of produce of such of the societies as choose to take advantage of its services shall be conducted. This is felt to be a natural development of the movement. The federated societies which are in a position to deliver milk by road transport to buyers' premises sell direct to the retail city distributors, and in only two instances have societies engaged in retail distribution themselves.

This new departure is being watched with interest, but it is too soon to offer an opinion as to results.

A phase of the dairy industry which has not so far been dealt with in this paper is that conducted by occupiers of farms situated contiguous to towns or within a radius of 5 miles from populous centers. Each farmer either retails his milk direct to the consumer or, in some cases, delivers it to retail dealers for early morning distribution.

Cooperation has not so far appealed to that class for the reason that they are able to obtain the highest price going, and prefer to continue working on individualistic lines. But this system has its drawbacks. There is much waste of time and overlapping in the case of those who retail to the consumer. There is also often a tendency when the demand is slow to undercut prices, or to offer as an inducement to the buyer extra measure.

There is, however, one notable instance where farmers of this class in 1912 formed a cooperative milk distributing society in a northern town, with a paid-up capital of £1,330 15s. The membership consists of 20 milk producers who formerly retailed milk direct to the consumers. Now they deliver their milk to their own distributing depot in the town, where it is bottled and delivered to the consumer in a systematized manner which involves the minimum of labor and entirely obviates overlapping or undercutting of prices. The sales of milk and milk products for year 1922 totaled £40,-495 1s. 7d., the working costs amounted to £3,477 9s. 10d., and the net profit for the year £307 7s. 10d.

The society has proved a great success, and it is hoped others similarly situated will in time imitate their example.

There are likely to be far-reaching developments in the near future in regard to the production and distribution of milk. A milk (special designation) order has been issued by the Ministry of Health. Compliance with the order is not so far compulsory, except in the case of those producers who apply for a license to deal in the classes of milk specified in the order. No doubt papers

will be prepared for discussion at the congress dealing with this aspect of the question. The writer therefore contents himself by adding that if there should arise a demand by the public for specially treated milk, no class of producers are in a more favorable position to meet that demand than the organized farmers' cooperative dairy societies.

THE METHODS THAT HAVE BEEN USED BY THE COOPERATIVE MARKETING ASSOCIATION IN HOLLAND, AND THE RESULTS THAT HAVE BEEN OBTAINED.

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During the first years of the existence of cooperative butter and cheese making in Holland, part of the butter was sent abroad on consignment to special importers. A special characteristic of this form of sale was that the difference in quality of various shipments of the butter was not expressed in the price. In order not to lose ground, every importer did his utmost to live in peace with all men; and with this end in view he thought he could do no better than to divide the total amount of the proceeds among the shippers of butter as equally as possible, without taking into account the value at which each individual parcel had been sold. As soon as investigation had brought this fact to light, it was understood by the cooperative dairy industry in this country that such a selling system would prevent improvement of the quality.

The question then was how to find a way in which it would be possible to inform the producer at any moment of every detail of the condition of his shipment and, at the same time, its exact value. In this way, the best butter would yield the highest price, and consequently the improvement of quality would become remunerative and necessary.

These circumstances have led to the establishing of a cooperative export association for a special part of the country, consisting exclusively of cooperating dairy factories. Such an association will never have any chance of success if every stipulation, whether in writing or not, be not observed in strictest loyalty. Even the slightest deviation would destroy its inner strength, for the latter derives its significance from that same loyalty which, like domestic loyalty, is claimed from every member of the cooperating factories. The fact that any individual action concerns the whole, and, though performed by the one hand, is under many-sided control, makes it, practically speaking, nearly impossible successfully to deviate from the right way.

A very important condition for the most advantageous selling is the continual improvement of the quality of the article itself. Only when there is an intimate and regular contact between production and sale, will it be possible to comprehend all the factors which affect the improvement of the quality. It is desirable that production and sale should be intimately connected. The consequence will be that the production system will gradually attain its highest degree of perfection. It is needless to say that this result can not

be obtained without care, tact, and application, but it may be stated as well that the very difficulties of this task amply warrant success.

Let us point out now the results which have been obtained by the above-mentioned association by this mode of sale. The first thing the association had to do was the registration of its own trademark, which, together with the countermarks of the different co-operating factories, was to be applied to every package of butter.

A representative was appointed for each particular outlet. He could apply for the quantity of butter he could place at the price fixed beforehand, and, for the rest, his obligations were detailed by nearer instructions. It was stipulated that immediate information should be given of any deviation in the quality of any shipment. In direct connection with the sale, a weekly inspection of all butter was instituted from the very beginning. With this inspection, mutual discussions of the managers of the cooperating factories were possible.

When appointing a responsible manager, it was considered advisable to choose a man for his own community, so that business relations might develop on a friendly basis, and the association might thrive in a natural way. For 25 years this has been the system of operation of the association, and we are glad to state that these original stipulations regarding the conduct of the business have remained quite unchanged. We must add that the work of the association has undergone an important development in that the sale of cheese has been added to the business of the association. Thus experience has developed a system in which manufacturing and sale are continually complementary to each other. It goes without saying that this could not be attained without bringing the different persons, charged with the execution of the work, into regular contact with each other. On one hand, this is done by the intervention of the responsible managing director, who takes special care of the sale; on the other hand, there is an independent expert for the technical part of the business, who pays his special attention to the quality of the produce and assists with his advice whenever required.

The association is represented now in all importing countries of the world, and has, moreover, at its disposal an intelligence department which enables the general manager to survey the changes in price from day to day, as well as all other particulars concerning sale. These data have given rise to the development of the technical department, which has gradually become independent, and which, in addition, to the above-named department for controlling the quality, finds a very extended sphere of activity in the management of the storing facilities, and especially the cold-storage warehouses of the association. In this regard, experience has shown that, as to the sale of products, it is of utmost importance that both storage and forwarding satisfy the highest demands.

It is for this reason that, during a short period, all butter is stored at a low temperature before shipping, and afterwards is sent to destination in refrigerator cars made for the purpose. As these refrigerator cars are owned by the association, every shipment can be forwarded separately, so as to deliver the butter in firm condition to every customer.

Some of the cold-storage warehouses are reserved for the storage of cheese, which demands a longer period for ripening at a low temperature. Also, on very hot summer days, the compartments designed for the storage of the ordinary sorts of cheese can be held at such temperatures as are thought desirable.

In other respects the sale of the products has continually made new demands on the technical department. As far as those demands refer to manufacture and packing in the storerooms, a special way of operating is rigidly observed, so that one improvement after the other develops in the course of the work.

Regarding the manufacture, these demands are discussed at the regular weekly conferences of the managing directors of the co-operating factories with the members of the managing board. After general consideration of all particulars concerning the turnover, discussions take place every week concerning the technical details of manufacture, in connection with the inspection of the product. The results of these discussions, as well as those about the turnover, are immediately communicated to all cooperating factories. On the other hand, the members of the managing board have an opportunity to take advantage of these weekly conferences for the benefit of the whole association.

It will be clear that all this began on a very humble scale, and followed closely upon the old state of things, when dairying was carried on at each farm. After all, things have remained very much as they were, except that more hands are cooperating in the original working scheme. Just as in former times, this work gives interest and significance to the life of the farmer, and is for him a guaranty that the productiveness of this part of his underaking is raised to its highest pitch.

In former years the butter-making farmer's wife in this country was famous all the world over; and with regard to the more scientific butter making of the present time, the only difference is in degree.

The idea which underlies the admirable development of the dairy cooperation in Holland is the same idea of the past that will more and more inspire all those who are concerned with this mutual task; the love of the ancient trade has once more expressed itself in the above-named association, an organization founded not by a few, but as the natural result of the cooperation of all. This idea may be disturbed, or even for a time be lost, but it will revive again and again, because it contains something of a lasting character.

COOPERATIVE CREAMERIES IN IRELAND.

THE IRISH AGRICULTURAL ORGANIZATION SOCIETY, DUBLIN.

The dairying industry has, from time immemorial, been one of Ireland's greatest sources of wealth; it has also been and still is the "key industry" in the agricultural economy of the country, for upon its existence depends the production of cattle, the export of which easily heads the list of Irish exports. The production of pigs and the Irish bacon-curing industry—famous throughout the world—also largely depend upon the maintenance of an efficient and widespread system of dairying; while yet another industry—that of

poultry raising, with egg production, second only in importance to that of cattle production—depends in a great measure on the success of dairying, as milk is a very important element in the feeding of poultry, especially those which are bred and fed for table purposes.

This argument will be best explained by quoting the latest available figures from the Report of Exports and Imports for the year 1921, published by the Department of Agriculture and Technical Instruction for Ireland, which are as follows:

Exports of meat, dairy, and poultry products from Ireland.

Livestock: Sheep, beef, and mutton-----	£24, 921, 397
Butter, cheese, milk, and milk products-----	7, 122, 768
Eggs, poultry, and feathers-----	11, 071, 834
Total-----	£43, 115, 999

Prior to the year 1880, Ireland had virtually held undisputed supremacy as a butter-producing country. The industry was traditional, and almost every country in the world was a buyer of Irish butter, then made by the farmers in their home dairies, according to formulæ handed down from each successive generation of butter makers to the next. Neither the quality of the product nor its uniformity would secure it any place in the world markets of to-day, but in the seventies, Irish butter was the best procurable, apart from a comparatively small quantity produced in Brittany, which was mainly sold in Paris. Cold storage—a very doubtful blessing, except where butter has to be transported from distant countries—was not then available, so Irish butter, especially that intended for winter consumption, was usually heavily salted.

It was at this juncture that the centrifugal cream separator was invented in Scandinavia, and was almost immediately put into use in Denmark and Sweden. By its means the cost of manufacture was decreased, the volume of butter increased, and a degree of uniformity, hitherto unknown, was attained, both as regards quality and character. The Danes laid siege to the Manchester and London markets and, by making great temporary sacrifices in price, secured these markets for their product. They still deservedly hold a very high place in those markets, but other countries have since then adopted identical methods and are doing battle with them for the British trade.

Ireland was late in entering into this world competition and, to this day, has a great deal of leeway to make up. Irish farmers, like their prototypes the world over, are intensely conservative and notoriously slow to change their methods. And this was no mere change that was demanded of them; it was virtually a revolution, for it meant the conversion of a time-honored and patriarchal home industry into a factory industry. The individualistic instinct of the Irish farmer revolted from the idea of handing over his milk and, what was even a greater concession, the sale of his butter to a factory, even to a factory in which he himself was part owner. Many dairy farmers, finding butter making no longer profitable, sold their dairy cows and reverted to "dry-stock" farming. This had disastrous results for the country. The abandonment of dairying left without employment many thousands of girls who earned their living

as milkers on dairy farms, and also laborers who had been previously employed in raising crops for the feeding of the large dairy herds, especially in the Province of Munster. The only alternative for these unemployed workers was emigration, and those who could do so crossed the ocean to America. The rich dairying lands seemed to bid fair to become vast pasturages where the main occupation of the few remaining workers would be the opening and shutting of gates and the harvesting of the hay.

About that time, the late Canon Bagot, who had studied the dairying industry in Denmark, made an attempt in the south of Ireland to establish creameries, equipped with cream separators, power-driven butter workers and churns, and succeeded in starting several which were organized as joint-stock companies. Simultaneously, certain merchants engaged in the butter trade, seeing the way the wind was blowing, built and equipped creameries, worked as proprietary concerns. But in neither instance had the constitution of the venture in it the element of permanence, for there was no necessary identity of interest between the shareholder and the milk supplier in the Bagot joint-stock creameries; while, in the proprietary concerns the owners made no secret of it that their object was to extract the maximum of profit from the business. To-day not one of the Bagot type of creameries survives, while the proprietary concerns are gradually passing into the hands of farmers' cooperative societies.

It was not until 1889 that Sir Horace Plunkett started his cooperative crusade, which aimed at making every Irish dairy farmer a co-operator, and at securing for him, through joint action with his fellows, the sole control and all the profits of his dairying business from beginning to end. The progress of this new movement was painfully slow in its early years. Sir Horace's efforts were received with apathy by the farmers in most instances; and with open opposition from trading interests, who conceived their interests to be threatened; and also by prominent Irish politicians, who regarded the new economic movement as a "red herring" drawn across their track in seeking home rule for Ireland. But the main difficulty lay, not so much in the distrust of the Irish farmers of the promoters, or in this opposition, but in their distrust and suspicion of one another. They had never hitherto combined for business purposes, and they hesitated to join in a venture with untried partners, moreover a venture which involved a considerable capital expenditure.

Persistent endeavor by Sir Horace Plunkett and his associates, and, since 1894, by the Irish Agricultural Organization Society, has resulted in the formation of 445 cooperative creameries, with a membership of 49,959, a share and loan capital of £636,179, and a trade turnover, for 1921, of £5,661,518. The equipment and management of the majority of these cooperative creameries leave very little to be desired, and the fact that they have survived the bitter internal struggle of the last three years is, in itself, a testimony to their stability. The basis of every society is democratic. The capital is mainly subscribed by the milk-supplying farmers, and the interest on the shares is limited to 5 per cent per annum. Their rules provide that the remaining surplus is divisible, pro rata, among the milk-supplying members and the workers in the concern. Practically all of them contribute

annually a subscription to the Irish Agricultural Organization Society, in proportion to their trade turnover, in exchange for which they receive advice, inspection, and other aids to their undertakings. Each society is an autonomous body, is incorporated under the industrial and provident societies act, and is managed by a committee of its members, elected on the democratic basis of "one man one vote."

The educational value of the societies in business methods has been almost as valuable to Ireland as the material benefits they have secured for their members. They have provided a common platform for all creeds and classes and for persons differing widely on political questions. All Irish societies have a fundamental rule excluding the discussion of any political or religious question, and this rule has been strictly and honorably observed.

Most successful cooperative creameries have of late years added to their activities that of supplying their patrons with agricultural seeds, fertilizers, feeding stuffs, machinery, farm implements, and also household requirements. Several have taken up the marketing of eggs and poultry. This development, apart from its material utility, has done much to bring the farmer and the farm worker (who is usually a poultry keeper and always a customer for household goods) into cooperation with each other, a very real benefit to the whole rural community.

In many parts of Ireland, even in dairying districts, it is almost impossible to draw the line of demarcation between the small farmer and the laborer. Latterly, it has become even more difficult, for, with the increased rate of agricultural wages, the lot of the laborer is now often more enviable than that of the small farmer. Still, the division between them—a vicious division it must be admitted—remained, but it is hoped and believed that in the cooperative society may be found the bridge over which each class may pass and repass without loss of self-respect, and with a growing understanding of each other's difficulties and a full appreciation of the fact that in the prosperity of agriculture lies the ultimate prosperity of farmers and farm laborers alike.

Taking into consideration the condition of the Irish dairying industry when cooperation was introduced 34 years ago, its promoters may to-day congratulate themselves on their achievement. But those who see the movement at close range are painfully alive to its shortcomings, and must admit that the main achievement has been the transformation of an ancient but obsolete home industry into a factory industry, with its attendant advantages of economy, increased production, some degree of uniformity in character, and a marked improvement in quality which has, naturally, resulted in an enhanced price. These attainments are all a real gain; without them the Irish butter industry must have shared the fate of many other ancient (also flourishing in their day) Irish industries. But, the fact remains that cooperation among Irish dairy farmers is still open to many criticisms, and many of its critics are merciless. They point mainly to the failure of the movement to achieve:

- (1) The loyalty of members to one another and to their society.
- (2) Any increase in the average milk yield of Irish dairy cows.
- (3) Any increase in winter production.

(4) A system of cooperative marketing of the produce, which presupposes—

(5) A rigid system of "control," or standardization of the processes of manufacture.

Dealing with these failures seriatim, it may be argued:

(1) That loyalty can be expected only when an improved system of education on practical lines is introduced and a thorough understanding of cooperative principles comes about. It is not compulsory in Irish cooperative creameries for patrons to be shareholders, and where they take shares the investment is not sufficiently large to make it a matter of much importance. This is, admittedly, a grave defect. The rule that milk should only be accepted from shareholders, bound to supply milk for a reasonable period of years, should be introduced and enforced.

(2) The average milk yield of Irish dairy cows is to-day under 450 gallons per annum, which was where it stood in 1889. Expert opinion is unanimous that, with very little effort, individually, Irish dairy farmers could grade up their cows to a production of 600 gallons, an increase of 33 per cent. It might be imagined that their own enlightened self-interest would have led them to carry out this obvious reform. Their reluctance, or neglect, to do so may be attributable to the widespread belief that beef-producing qualities can not be expected from the progeny of a good milk cow, but it is more probably due to the inherent dislike of the farmer to conform to the essential rules of a cow-testing association which, to be of any value, must be very exacting.

(3) It is very doubtful, now, if the winter production of butter in Ireland can be demonstrated to be an economic or, at all events, a paying proposition. The increased production of grass-fed butter in the antipodes and the perfection of cold storage have certainly made it more difficult to get the Irish farmer to catch on to the idea. Moreover, the recent conflicts between employers and employed in rural districts, affecting, as they do, the dairy farmer's business in particular, and the greatly increased rate of wages, leave one in some doubt whether winter milk production for butter-making purposes ought to be advocated, though, beyond doubt, winter milk production for town supplies ought to be maintained and ought to yield a good profit. (It may here be noted that milk is dearer in Dublin than in any other city in these islands.)

(4) Many attempts have been made to organize a system of cooperative marketing, but none has succeeded. The Irish Cooperative Agency Society has probably done more in this direction than any other body, and has reaped its reward by to-day occupying the position of the largest shipper in existence of Irish creamery butter. It operates, in the main, just as any other butter merchant does; it either buys "firm" or sells on commission: it buys or sells all the butter that comes its way. It is regarded by the societies in the light of a "friendly broker," but that is all. If they think they can get better prices elsewhere they sell elsewhere, and thus become competitors of the agency society.

(5) Those who are best qualified to judge have been forced to the conclusion that the one and only way to succeed in carrying out a cooperative marketing scheme for butter is to secure, under contract

if possible, a certain regular supply of high-grade butter, made in accordance with the recognized principles which regulate the standardization of every stage of the process of manufacture. Butter made in this way ought not to vary appreciably, either in quality or character, and can, therefore, be safely offered for sale under a national brand. As Irish butter, at its best, is absolutely the best butter in the world, it is lamentable to see some of it turned out and marketed in such slipshod fashion that it can not even obtain the doubtful advantage of being sold as the product of a competing country, but, to our eternal disgrace, must be sold for what it is—Irish butter.

In this way the reputation of the country is being damaged almost (but I hope not quite) irretrievably. There is no country in the world so favorably circumstanced as Ireland is for the production of a first-class butter for sale in the greatest and best market in the world. Alas, there is no country which is putting forth so little effort to capture and hold that market against all comers.

COOPERATIVE CREAMERIES IN THE MISSISSIPPI VALLEY.

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Of the 1,153,515,000 pounds of creamery butter produced in the United States in 1922, 803,504,000 pounds, or 69.2 per cent, were manufactured in the nine States located in the north central Mississippi Valley. There are several factors which have served to bring about the development of dairying in this section. Climatic conditions are favorable, both for the rearing of stock and the raising of foodstuffs necessary for their sustenance. Being a region which is by nature adapted to diversified farming, the various feeds necessary for a balanced ration are easily obtained. The luxuriant growth of clovers and grasses provides pastures in summer and hay for winter forage, the corn crops insure large yields of fodder and silage, the small grains, oats and barley, with the mill feeds, such as wheat, bran, and linseed-oil meal, produced in this section, all tend to furnish the nutrients necessary for economical milk production. Then, too, the abundant supply of pure cold water enables the producer to furnish a fine quality of milk and cream necessary for the manufacture of high-grade dairy products.

In the leading dairy States in the Mississippi Valley, most of the butter has been made in cooperative creameries, and this has perhaps been one of the most important factors in bringing about a rapid dairy development, as it has insured the most satisfactory market for the dairy farmer. Within the last few years, great strides have been made along dairy lines in the southern Mississippi Valley States, and it is noteworthy that wherever the cooperative creamery has been introduced, and properly managed, a more satisfactory market for milk and cream has been provided, than where the proprietary creameries have controlled the manufacturing end of dairying.

Prior to 1890, practically all the butter made in the upper Mississippi Valley was made from cream separated from milk by gravity,

but about this time the centrifugal power cream separator was introduced. This machine offered several advantages over the gravity skimming; its use not only made possible a more complete recovery of the butterfat from the milk, but it also insured a better quality of cream. Its use did away with much drudgery and hard work on the farm, and for these reasons the power cream separator soon came into general use.

The Babcock test was also invented about this time. By the use of this test it became possible for the creamery man not only to determine the butterfat content of milk and cream purchased, but it enabled him to ascertain the mechanical losses incident to butter making, and thus it helped to solve many of the problems of minimizing the heretofore unknown losses which had handicapped the creamery man. This test was also of inestimable value to the dairyman, as it enabled him to test the production of his cows, and to weed out the unprofitable ones, and thereby helped the dairyman in building up better milk-producing herds.

Up to this time practically all the creameries were proprietary or individually owned. Since these creameries were built for profit, the owners had but one motive in mind, that of making the largest possible profit. The larger the make, the greater the profit, for the reason that the owner's profit was calculated on a fixed profit per pound of butter made. This led to the establishment of cream routes, or the collecting of cream by haulers sent out from the creamery. Little if any effort was made to encourage the production of good cream, and consequently a poor quality of butter was made, and the farmer was poorly paid for his milk and cream. Certain agencies had already been at work in an effort to organize cooperative creameries, but since the promoters were actuated by selfish motives, either as builders of creameries or in order to sell creamery machinery, the organizations which they promoted were in reality not cooperative. The organizations which the promoters succeeded in forming were stock companies, and as shares of stock were usually sold to others than producers of milk, the success of the creameries was judged more by the cash dividends paid on shares of stock than the price paid for milk and cream; therefore the plan was not at all satisfactory to the farmer.

Progressive dairymen realized that in order to succeed it would be necessary for them to build and operate their own creameries on the cooperative plan, and crude as were the first articles of agreement and the by-laws under which they were operated, the principle of cooperation was sound, and within a comparatively short time, a number of creameries were in successful operation. The patrons of a cooperative creamery soon realized that inasmuch as they were partners in the business, every effort made by them to improve the raw material would be rewarded by higher prices paid for butterfat. It was but a short time before the dealers in all the leading markets recognized the quality of butter from the cooperative creameries as superior to any other.

The whole-milk system facilitated the manufacture of fine butter because this system required frequent deliveries. The milk, produced in the immediate vicinity and hauled but short distances, in-

sured a fine quality of raw material. Within the following 10 or 12 years, with the advent of the hand separator, new obstacles appeared. The proprietary creameries which had survived were as anxious for quantity as ever. While they were unable to compete with the cooperative creameries under the whole-milk system, with its resulting high prices paid to the patrons, they were again able to transport the less bulky farm-skimmed cream from wider areas, and, especially in sparsely settled localities they reestablished cream routes. Although a lower price was paid for butterfat, the farmers in many localities deserted their cooperative creameries and patronized the proprietary creameries.

At first the proprietary creameries were limited as to the distance from which cream could be collected only by the distance which haulers could cover in a day. In some instances relay routes were tried, but these were usually not practical for the reason that the cost proved prohibitive. In order to cover greater areas, some of the proprietary creameries resorted to the transportation of cream by rail. Being successful in securing advantageous rates on express shipments, it became possible to ship cream from almost unlimited areas. This led to the establishment of the so-called centralized creamery. That the quality of butter suffered by this system can never be questioned, but, since most of these creameries were located in cities, or where their output could be sold while fresh, the consumer buying in small quantities used the butter immediately; therefore the true character of the butter was not detected. Through the advantage of home markets, the centralized creameries were enabled to sell their butter at better prices than if they had been forced to sell on the open market.

The cooperative creamery, on the other hand, was really an adjunct to the farm, and its function was to furnish the farmers of their respective communities with an advantageous market for their cream. The success of a cooperative creamery should be based on efficiency in manufacturing the producer's cream into the highest possible grade of butter at the least cost, and by so doing, it provides the most satisfactory market for the farmer's cream. The cooperative creamery had the advantage that the operator was in constant touch with his patrons, and therefore was in a position, not only to encourage the production of good cream, but to encourage better methods of feeding and better care of the cows; and this, in turn, has resulted in greater production and the building up of dairy communities.

The agricultural colleges, in the respective States, have done much toward the training of men for creamery work by courses offered in the dairy schools to men who previously had had some practical creamery experience. These courses enabled the prospective creamery operator to get the fundamentals of dairying, both as to the factory and the production end, and therefore the cooperative creameries have profited by employing well-trained men as operators of their factories. The educational butter-scoring contests in the various States have also been of inestimable value in creating an interest amongst the creamery men toward making the highest possible

grade of butter, and it is noteworthy that it is the butter makers of the cooperative creameries who participate by entering butter in these contests. The butter makers' associations in all the leading dairy States have also done much toward the encouragement of efficient operation of the cooperative creameries.

In order to insure a low cost of manufacture, it is of course just as necessary in a cooperative as any other creamery to have sufficiently large volume of business so that the cost of manufacture can be kept down to a minimum. It is nevertheless of interest to note that a cooperative creamery, efficiently operated, and making a high-grade butter, manufacturing from 200,000 to 300,000 pounds annually, can usually make a very creditable showing in prices paid to patrons.

The success of any creamery depends on efficiency in operation, and it is admitted that the proprietary creameries, as a rule, are well managed, and careful check is kept to avoid any possible losses. The composition of the butter is controlled and every precaution is taken to prevent any unnecessary mechanical losses; it must be admitted that the cooperative creameries have been more lax in their methods, due to the fact that the operation of the creamery has too often been left to the butter maker, and unless close check is kept of every detail preventable losses occur. It is noteworthy that the most successful cooperative creameries have profited by the business methods of their competitors in maintaining careful check on all matters which pertain to efficient work in the creamery.

One of the most difficult problems which has confronted the cooperative creameries has been the making of a uniform grade of butter. Every creamery has been a separate unit where the butter maker has been the sole judge, and therefore there has been a lack of uniformity. There has been no general supervision from the outside which might tend to work toward a standard quality. With the use of the hand separator on every farm, this problem became even more difficult. The delivery of cream has become more irregular, and as a result more or less aged and soured cream is being delivered to many of the creameries. The making of a uniform grade of butter from the cream soured on the farm, or from mixed lots of sweet and sour cream, is a very difficult task. The souring or ripening of cream with a view to develop desirable flavors in butter is a delicate task and at best uncertain of the best results. The keeping quality of butter is rendered more uncertain where any appreciable development of acid has been permitted. There has, in later years, been a general demand for butter of a mild flavor, possessing good keeping quality, and to meet this demand it has become the practice in many of the creameries where starter is used not to allow any acid to develop in the cream. To avoid overripening, the starter is added after the cream has been cooled to churning temperature; this method has proven a help in making not only a more uniform quality, but a butter possessing a better keeping quality.

The Dairy Division of the United States Department of Agriculture has, after making exhaustive study and experiments in regard to causes for deterioration in butter, found that butter of fine flavor

and possessing safe keeping quality can best be assured by making butter from Pasteurized sweet cream, churned without the addition of starter or any ripening whatever. A large number of experiments were conducted, but the following table covering one set of experiments will show the results obtained by three methods of making butter, comprising 128 churnings:

TABLE 1.—Average deterioration in score of butter after storage for eight months.

Kind of butter.	Number of churnings.	Average score of fresh butter.	Points lost during storage at zero temperature.
Ripened raw cream.....	39	92.99	3.2
Ripened Pasteurized cream.....	53	93.42	2.0
Unripened Pasteurized cream.....	36	93.82	.5

These experiments were made in the hope of devising some method for making butter possessing good keeping quality for the Navy Department, and in 1909 contracts were awarded according to specifications prepared by the Dairy Division, and these specifications, with but minor changes, have been followed ever since on all Navy butter contracts.

Butter made by this method lacks the high flavor which the trade had been accustomed to, but it does have a mild, delicate flavor characteristic of sweet cream, and, in addition, it has splendid keeping qualities. For several years the trade did not appear to be interested in butter made from unripened cream. It was really not until about five years ago that attempts were made in a small way to sell butter made by this method on the New York market under the name of sweet cream butter. That butter made by this method has been winning favor with the consumer who has become attracted to it by the uniform mild delicate flavor and splendid keeping quality, is perhaps best proven by the fact that the demand for this butter has become so general that a premium is being paid over the highest market quotations to creameries producing this quality of butter. The cooperative creameries have thus become more interested than ever in maintaining the lead in the matter of quality; the result has been that it has practically revolutionized the methods of making butter wherever sweet cream can be obtained. By the use of this method, the cooperative creameries not only make a more uniform fine quality, but the purchaser is assured a more safe-keeping quality and a safe investment for storage purposes. It is generally conceded that if the butter is made from unripened Pasteurized sweet cream it will come out of storage practically as fine as when it was made.

As has already been stated, the cooperative creameries in the upper Mississippi Valley have not only held their own against all competition, but in some sections are actually gaining, as will be shown

by the following figures published by the dairy and food commissioner of Minnesota, relative to the creamery industry in that State:

TABLE 2.—*Number and types of Minnesota creameries.*

Year.	Number of cooperative creameries.	Proprietary creameries.	Centralized creameries.	Per cent of cooperative creameries.	Per cent of butter made by cooperatives.
1914.....	622	189	39	73.2	61.4
1917.....	643	159	39	76.4	61.7
1919.....	622	145	44	76.6	63.7
1921.....	645	139	47	77.6	67.1

From the above table it will be seen that the cooperative creameries have been steadily gaining in this State. Statistics of this kind are not available from the next largest dairy-producing States in this section, namely, Wisconsin and Iowa; but if the number of cooperative creameries in these States is considered, it is estimated that the ratio of the butter made by the cooperative creameries is about the same as in Minnesota. In the other Mississippi Valley States, however, the proprietary creameries predominate.

The most recent important development amongst the creameries is the organization of cooperative associations by the creameries within their respective States. These organizations band the creameries together for closer cooperation, both in the manufacture and marketing of their butter. Assistance is given the creameries through field service men, who endeavor to bring about greater efficiency in the operation of the creameries, and especially along the lines of improving the quality and marketing problems. Though these organizations are but recently formed, good results have already been attained through cooperation between the producing and marketing agencies.

COOPERATIVE MARKETING OF CHEESE BY PRODUCERS: ITS DIFFICULTIES AND ADVANTAGES.

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The commercial cheese industry of the United States through its 3,530 factories created \$143,455,000 worth of product in 1919. It comprised almost 400,000,000 pounds of cheese. Wisconsin was the leading State, with 66 per cent of the output, followed by New York with 17 per cent, and Minnesota, California, and Oregon, each with from 2 to 2½ per cent of the Nation's output. In all the remaining 43 States only 10 per cent of the cheese was produced.

Cooperative marketing of cheese as an individual product on a commodity basis has been undertaken successfully in an extensive manner in only three States—Oregon, Wisconsin, and Minnesota. Thus far, less than 6.5 per cent of the Nation's cheese has been cooperatively sold. This has been accomplished by two notable organizations—the Tillamook County Creamery Association, of Oregon, and the Wisconsin Cheese Producers' Federation, operating in Wis-

consin and Minnesota. The extent of cooperative commodity cheese marketing is fairly shown by the following comparative figures:

TABLE 1.—*Extent of cooperative commodity cheese marketing in the United States during 1922.*

Territory.	Total cheese marketed.	Cheese marketed co-operatively.	Per cent marketed co-operatively.	Name of organization marketing.
	<i>Pounds.</i>	<i>Pounds.</i>		
Entire United States.....	399,239,446	25,489,453	6.4	Two companies named below. Wisconsin Cheese Producers' Federation. Tillamook County Creamery Association.
Wisconsin.....	263,481,352	16,102,018	6.1	
Minnesota.....	9,766,750	2,771,478	28.4	
Oregon.....	8,465,000	6,615,957	78.1	

Two purposes evidenced by these figures have undoubtedly been in the minds of those contributing to the cooperative marketing of cheese. One of these purposes which has been the mainstay of the leaders is to build an organization that will render unmatched service to farmers and consumers. The other purpose, which has caught the sentiment of the farmer through his characteristic opportunism, is the overpropagandized idea that cooperation will win for farmers not only higher prices but also enlarged profits. Neither of these popular assumptions necessarily results from cooperative marketing. As a consequence, to quote a leader in one of the largest and oldest of American cooperative sales companies: "The bitterness and disappointment that follow the inevitable disillusionment may very well prevent or retard the development of the cooperative idea in its sounder and better aspects."

SERVICE IS PURPOSE OF COOPERATION.

If cooperative cheese marketing be viewed from the standpoint of enduring as a protection and aid to farmers, it must seek to root out of the feelings and understanding of members their popular interpretation of cooperation. It must plant and inspire in members the idea that cooperation is primarily a means of first serving the trade and consumer better, before the rewards of higher price or profits may be expected for farmers. Cooperation, as one of several means of insuring that the work of marketing shall be done, is necessarily concerned with the problem of having farmers comprehend what the work of marketing really is. Broken into its parts, marketing consists of a series of services,¹ including assembling, grading and standardizing, packaging, processing, transporting, storing, financing, distributing, risk spreading, and selling. Unless these services are performed consumers can not utilize farm products. If rendered inefficiently, farmers receive for their commodities unremunerative returns. Here, then, is the goal of cooperative cheese marketing: To satisfy consumers with product and service, and do so with a degree of efficiency which improves upon the performance of private marketing as thus far demonstrated.

¹ See *Efficient Marketing for Agriculture* (The Macmillan Co., New York), pp. 28-29, and Chaps. 111 to XI. Wisconsin College of Agriculture, Circular 161.

PRIVATE MARKETING WEAKNESSES.

Among the many weaknesses in private marketing of cheese there are several evils of major importance. They have to do largely with the services of grading and standardizing, storing, and distributing. The reason these services are less well performed than they should be is in part due to the lack of coordination among private middlemen, to duplication among them, and to the consequent high proportion of mediocre management overseeing the marketing work of the country. One of the greatest weaknesses of the system is the practice of buying raw materials from farmers on a flat-price basis regardless of different grades or qualities. This practice breaks the influence of consumer prices and desires upon production, and hence stimulates undue production of the very commodities for which consumers have the least real demand. This more than any other single cause works hardships upon both farmers and consumers.

THE WEAKNESS OF COOPERATION MUST BE OVERCOME.

All of these weaknesses in cheese marketing are focused in the present personnel and operation of the cheese boards.² Wisconsin Cheese Board prices are arrived at by the estimates of those who offer cheese upon the boards and of those who present bids for this cheese. If either of the two boards were to operate perfectly—something that many deny, but which does not concern the purpose of this article—they could at best only register prices that would balance supply and demand. Now, it is well known that Wisconsin cheese is produced very unequally in different seasons and months of the year. The following percentages, based on the figures of actual production of 14,862,760 pounds by 136 American cheese factories scattered in all parts of the State of Wisconsin, amply illustrate this striking seasonal character of cheese production:

TABLE 2.—*Seasonal cheese production.*

Month.	Per cent of year's output.	Per cent monthly undersupply. ¹	Per cent monthly oversupply. ¹
January.....	3.38	59.4	.....
February.....	4.11	50.7	.....
March.....	6.66	20.0	.....
April.....	9.38	.....	12.6
May.....	10.93	.....	31.2
June.....	14.24	.....	70.9
July.....	10.90	.....	30.8
August.....	10.31	.....	23.7
September.....	10.15	.....	21.8
October.....	8.72	.....	4.6
November.....	5.84	30.0	.....
December.....	5.38	35.4	.....

¹ Per cent undersupply as well as oversupply is calculated on basis of the average monthly production of 8.33 per cent of yearly output.

CHEESE SUPPLY AND DEMAND UNBALANCED IN WISCONSIN.

Cheese factories deliver their cheese to dealers, of which there are in the neighborhood of 100 recognized firms in Wisconsin. Few,

² Hoard's Dairyman, Vol. LXV, No. 11, Mar. 30, 1923, p. 404.

if any, of the State's 2,800 factories have storage facilities, nor do they individually undertake to store their proportional part of the State's monthly or seasonal surplus of cheese for release later when the period of undersupply returns. The work of adjusting the seasonal variations of actual supply and demand is left entirely to the inclinations of those who, as private operators, can not manifest more than a secondary interest in behalf of the dairy farmer. Consequently, it is through the medium of less than 100 dealers—each with his individual speculative or estimating or guessing idea, which ever you wish to call it, as to how he may make a profit—that demand is registered upon the cheese board. And it is this interpreted demand alone that is felt upon the board in arriving at prices for an extremely seasonal product. The consumer's real annual demand is not felt upon the board.

By grouping the facts according to seasons the real nature of this problem becomes more apparent.

TABLE 3.—*Surplus summer cheese for winter use.*

Season.	Months.	Actual production in per cent of year's output.	Under-supply in per cent of year's output.	Over-supply in per cent of year's output.
Spring.....	March, April, May.....	26.97	.....	1.97
Summer.....	June, July, August.....	35.45	.....	10.45
Fall.....	September, October, November.....	24.71	0.29	.....
Winter.....	December, January, February.....	12.87	12.13	.....

The misfit of production to consumption is shown in summer oversupply and in winter undersupply. The surplus May, June, and July cheese, the grass product, if suitably made, is the very cheese that can safely be stored. It is also adequate in quantity to meet the needs caused by short winter production. Because good grass cheese, when stored, becomes more valuable through aging, it would be inherently more valuable than the cheese of any other part of the year, were a system in operation to store it in sufficient quantities to offset the winter scarcity.

All of these facts are well known to intelligent and experienced cheese dealers. But they also know that were the full surplus of summer actually stored, winter cheese would not rise to the profitable levels of price which short winter supplies oblige consumers and the wholesale and retail trades to pay. Here, then, is the joker in the cheese board possibilities. Dealers can not afford to store the amount of cheese that would have to be stored if prices were to be stabilized as between seasons. In this respect all profit-seeking cheese dealers stand on the same platform. They are disqualified from competing against each other to the extent of breaking their platform by storing enough surplus cheese to stabilize prices and meet the great industry needs from the farmer's point of view. Remember, also, that the storage of the full surplus of summer cheese and its effect on consumer cheese prices would vastly improve the consumer's lot. The farmer's and consumer's interest, as well as that of the vast hoard of retailers that make up three-fourths of all the middlemen, is identical on this problem.

BOARD PRICES ARE DUMPING PRICES.

Cheese boards are nothing more nor less than arrangements permitting cheese factories to dump their short or oversupply of cheese where dealers may easily exercise their voluntary kindness by accepting it at whatever they guess to be safe prices. Wisconsin Cheese Board prices are bargaining prices between different buyers, and are not in any sense bargaining prices between farmers as sellers and dealers as buyers. Board prices to-day, so far as the farmer's part is concerned, are dumping or sacrificing prices.

They must inevitably continue to be this as long as the farmer is not in a position to bargain in making them. It will take the construction of new conditions through organized sales to bring about actual bargaining prices where the farmer offers only as much as the dealer will bid for in the light of current consumer needs or real demand.

The mission of cooperative marketing in the cheese industry is to build up, especially, the services of grading, storing, and distributing, in such a manner as to protect the farmer's best interests. It is a task of confining the middleman's endeavor to render expert service as a means of paying farmers the largest part of what consumers pay, rather than of having middlemen operate to absorb as much of the consumer's dollar as possible in private profits.

TILLAMOOK PROVES VALUE OF MERCHANDISING.

This is precisely what the Tillamook County Creamery Association has accomplished.³ Through cooperative merchandising—and this simply means the application of scientific principles throughout the marketing of cheese—this organization has achieved as much as could be expected. It has demonstrated that the better results credited to cooperation actually come from the team work which cooperation makes possible. It is to this team work in the making of a superior standardized raw material and finished product, as well as team work among all the parties involved in delivering more of the better cheese to consumers, that the Tillamook farmer owes his thanks for premium prices. The sustained reward for cooperating at Tillamook is from 4 to 4½ cents a pound over Wisconsin prices, a premium amounting to 20 per cent. No wonder, then, that this system is conceded to be securing not only a "living price" but one which justifies the official statement that "all of our farmers are well satisfied with the price."

WISCONSIN FEDERATION ON THE WAY.

Tillamook success was the outgrowth of 19 years of slow growth. Ten years of cooperative cheese marketing by the Wisconsin organization have not enabled it to reach the high standard of service of its Oregon competitor. However, progress is being made as rapidly as the membership gains understanding of cooperation and faith in their institution.⁴ It has already demonstrated that cooperation can

³ Wisconsin College of Agriculture, Circular 161, pp. 6, 9, 16. Hoard's Dairyman, Vol. LXV, No. 11, pp. 404-5ff.

⁴ See Wisconsin College of Agriculture, Bulletin 346.

endure in doing the usual work of marketing. It remains to be shown that it can do in Wisconsin the unusual work of merchandising as efficiently as has been done by the Tillamook cooperators.

It is to be remembered that a number of highly efficient private marketing companies, such as the Kraft organizations, Phenix, and others, are not only constantly studying the consumer's wants but are gratifying them in ever increasing number and variety. To succeed, The Wisconsin Cheese Producers' Federation must engage ability of the highest order, so that its services will at least equal if they do not outdo those of their strongest competitors. Farmers have yet to learn that success in marketing grows from the same roots as success in a race. To win, the marketing organization must excel. It must outdo others performing similar services.

But excellence of service will result only from a management that possesses requisite knowledge, ability, and desire to be first in its class. The best private companies marketing cheese from Wisconsin sources employ men who have ability, who have acquired experience, and who receive the compensation to stimulate them to try at all times to take first place in what they do. They are men who say to themselves: "If the federation finds out how to improve, we will go them one better." Under such conditions, it is not an easy matter for an inexperienced, untaught, largely unthinking group of 5,000 or more farmers to perfect the team work that quickly wins its goal.

DRAWBACKS TO COOPERATIVE SUCCESS.

Here, then, is the weakness of cooperation. Would-be members of cooperative enterprises neither know how to be cooperators, nor do they sincerely want to work hard enough along certain lines to make their companies succeed. This is a harsh statement to make, but it springs from the experience of multitudes of farmers who have learned, after trying it, that cooperation brings success only when they as members jump out and push, instead of climbing on to ride. There is no such thing as a cooperative bus that will enable farmers to ride to a place of high prices and profits. But there is a cooperative team work that will help hard-working farmers to accomplish their ends better, more easily, and with greater satisfaction to themselves as they toil on.

The obstacles that retard cooperative cheese-marketing progress are by no means insurmountable. Tillamook has proved that most of the disadvantages of the present cheese marketing and producing system may be overcome. In short, the undesirable conditions in the cheese industry spring from the following conditions:

1. Farmers do not deliver to the cheese factory uniformly high-grade milk.
2. Cheese factories are needlessly numerous and hence of smaller size than efficiency requires.
3. Cheese makers are by no means either uniformly willing or at present able to make first-class cheese, or to work together to support a modern sales system.
4. Cheese marketing is divided among numerous wholesale companies which inherently can not render marketing services from the point of view of farmers or to the extent which farmers need them.

5. The lack on the part of cooperative cheese companies of adequate personnel having the necessary capabilities and experience in merchandising cheese.

6. The undesirable and unfair competition existing throughout the system of cheese marketing, especially with respect to conditions regarding moisture, quality, and weighing.

7. The general misconception by farmers of cooperative responsibilities, of what cooperation is. Its objects, and the basis of maintaining it as a useful agency of marketing.

PROSPECTS OF COOPERATIVE CHEESE MARKETING.

Were there no example in practical operation proving that the preceding list of obstacles could be overcome, the antagonist to cooperative endeavor would have a better case than he now has. The experience of the Tillamook farmers, however, has shown that all of these difficulties may be overcome. The farmer himself is his own best or worst forecaster as to the prospects for marketing his product. Uninformed, spiritless farmers who, seeing nothing in cooperative possibilities, also refuse to learn what it holds in store for them, certainly will find no help or consolation in the cooperative idea. To them practice will be impossible because they refuse to learn either signals or the point in the game.

On the other hand, for those farmers whose philosophy of life embodies the spirit of optimism and the pioneering courage which made their farms possible, there is a bright cooperative future because such men are discontented not to learn. They will delve to the depths of cooperative experience, and learn how to win the reward of skill in producing and marketing, knowing that this reward will never excel their skill.

COOPERATION ONLY A WAY TO DO THINGS.

Farmers must appreciate that cooperation is only one way of doing the work that must somehow be done. Under Wisconsin conditions—and three-fourths of the Nation's cheese is made in Wisconsin—farmers have their own local factories. These factories can serve as the basis for the organization of district groups for warehousing operations, and these district organizations, in turn, are able to federate for national sales purposes. These phases of cooperative organizations are more or less well known. The failures of cheese cooperators to date are less along these lines than they are in being unwilling to employ skilled service which is able to direct properly the work which must be done if farmers are to secure larger results than have accrued from the old system. At the present time the farmer should appreciate more perhaps than any other single fact, what his company ought to be able to do. Unless farmers comprehend the requisites of modern advantageous selling, they will refuse to approve of their own company's business policy. In so doing ruin is bound to follow. No company can stand still. It must go forward or backward.

In the last analysis, farmers will be cooperators because it pays, and none of the large cooperatives have been able to make it pay

which did not have a worthy goal, upon which their members have agreed. In cheese marketing, therefore, it is important that members should hold in mind that the purpose of their organization is to merchandise their produce, and that merchandising calls for:

1. A commodity marketing company to render necessary marketing services. It must be so created and operated that it renders unexcelled service with the greatest efficiency.

2. An adequate volume of business is essential to permit and insure minimum per unit cost of operation.

3. Standardized products must be produced for this company and must be absolutely dependable in quality and pack.

4. This standardized product must be attractively named and advertised. This means that it must be made known to enough consumers to win "two satisfied buyers where only one indifferent purchaser existed before."

5. The full and hearty backing and cooperation of the necessary distributing trade, such as brokers, wholesalers, and retailers, must be won and maintained.

6. Constant distribution of this standardized product must be so timed and placed that every consumer who desires to buy may be able to obtain the goods when they are wanted.

7. The farmer who makes the highly demanded product must receive a better price. In other words, the farmer must be enabled to get what his product sells for to the consumer, less only the necessary merchandising margin or cost.

If farmers of the cheese districts are willing to cooperate long enough to put these principles into practice, there will be little doubt left as to the brightness of the future of cooperative cheese marketing.

THE COOPERATIVE ADVERTISING OF DAIRY PRODUCTS.

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Cooperation in the dairy industry will achieve wonders, both as a service to the public who depend upon dairy products for nearly a quarter of their food requirements, and to the dairy farmer in enabling him to increase his volume of milk and to sell more at less expense.

Cooperation will easily find means and ways of utilizing the greatest of all forces in selling—advertising.

Examples are to be found all about us. Take, however, the example of the dairy industry itself. Wherever it has been given the helping hand of advertising, volume has increased and dairy herds have multiplied. New England gives notable proof of this. No States in the Union can boast to-day of a higher cow population. More attention is paid to dairying than to any other animal industry. In Massachusetts alone \$25,000,000 worth of milk and cream is produced. And through advertising, particularly as carried on by the New England Dairy Food Council—a combination of producer and distributor interests—the use of milk in New England cities is increasing tremendously.

Boston, for instance, uses more milk per capita than any other city in the United States. Due largely to the consistent cooperative and individual advertising in Boston newspapers, figures show that the railroad supply of milk and cream has grown almost 85 per cent during the past 10 years. In 1922 Boston's rail supply of milk increased 8,000,000 quarts over the previous year. Massachusetts farmers shipped to Boston over 15,000,000 quarts during 1922, an increase of 1,527,426 quarts over the previous year. The cooperative advertising of milk in Boston is in its fourth year, and in this year, the month of May showed an increase of 1,000,000 pounds for Boston alone. This shows that the dairy farmer should be keenly interested in advertising. It has increased the need of milk; it has made possible new methods of marketing dairy products. The extraordinary development of advertising has introduced the problem of trade-marked brands in the dairy industry, and has presented the new trade relation known as group marketing to be worked out. But, best of all, advertising has taught people to know values and has developed new wants. It is the wants of the millions that keep the wheels of business turning, and in the dairy industry, advertising and publicity of one kind or another have tied up the desire of people for good health with the kind of food that gives it to them, if any food can, and that is milk.

The most important question facing every dairy farmer is this: How can I increase my income to provide my family with not only the necessities of life but also the social and educational opportunities they should have. The answer is very simple: Produce more and sell more. You are both a manufacturer and seller of commodities; you are often too busy working at your specialty of manufacturing food products to spend much time in studying the selling end of your business. And yet we know that 95 per cent of all business problems are selling problems. In the old days, selling gave the dairy farmer little concern. To-day selling is the hardest problem in the dairy business.

Important changes are taking place in the means and methods of marketing food products. The tendency is to simplify the marketing process through cooperation by producers in the sale of their products. Cooperation will help the dairy industry achieve prosperity, as it has helped the producers of citrus fruits, prunes, almonds, apples, cranberries, flowers, and peaches. And because of this cooperation, advertising is made possible. The old idea of each man "paddling his own canoe" must give way to a brotherhood of producers; where men will depend upon the success of their united endeavors for their own prosperity; where they will think first of the dairy industry and secondly of themselves. And by organizing to do for themselves what nobody else will do for them, they will achieve what they could not achieve working as individuals.

The public profits from any organization that tends to establish stability for an industry.

Granting that cooperative marketing of dairy products is the better way, the modern way, the economical way, what is the right method of cooperation? It is vastly important to determine that. In California, very costly blunders have been made by applying the Rochdale system, which is a consumers' cooperative buying movement, to farm and marketing problems.

There are two types of cooperative organizations to-day, the cooperative marketing movement, known as the producers' movement, and the cooperative buying movement which is a consumers' movement. There is danger in confusing one with the other. There have been many instances here in the East, of farmers' cooperative organizations' getting on the wrong track because they did not detect the difference between the two movements. They entered the market without adequate knowledge of marketing methods, without knowing what the market absorption was or what the demand was. The result was a demoralized market and disaster to the farmers. Cooperation from the consumers' standpoint won't work. Profit-sharing, with speculators back of it and in control, is not cooperative.

Having chosen the right form of cooperative organization, you then come face to face with all the complex processes that are grouped under the term of marketing. Advertising, selling methods, trade relations, trade-marks, contracts, finance—these are some of the problems to be solved. In your enthusiastic efforts to market more milk and cream, increase the consumption of cheese and other dairy products, you will find that you have need for a thorough knowledge of modern business. You can not hope to become an advertising expert, a sales director, a business lawyer, and a financier overnight. That means, then, the employment of experts. To whom will you turn for assistance but to men who have made a lifetime study of their specialty as you have of yours. The California fruit farmer pays his sales director \$20,000 a year. He is an expert in a position where knowledge and strategy, born of long experience, are absolutely essential. Whatever salary the raisin growers pay their sales and advertising manager, it is not a bit too high. The idea of putting out small, convenient packages of raisins built a new factory. Within four months after the package was introduced, the sales at retail had mounted to \$16,500,000. That sales manager set out to find a new market for raisins—and he did. There are just as great possibilities in the dairy field.

The success of the advertising campaigns that promoted the sale of oranges, lemons, prunes, and other California products should encourage dairy farmers everywhere to set about finding new markets for dairy products. What you can sell is more important than what you can produce. Advertising, you must remember, is simply mass selling. Without advertising you can not hope to attain the increased sales you seek. As your venture into cooperative marketing grows, after you have reached a certain point in size, this is what happens: You will cease to be dependent upon middlemen to distribute your products. You will find it more practicable, and certainly more profitable, to establish your own methods of reaching your market. This, by the way, is not the least of the advantages to be gained.

If there is doubt in your mind that a staple, basic food like milk or cheese could be profitably advertised, consider the Boston milk campaign which is now in its fourth year. The first three months of the campaign showed an increase of 2,000,000 quarts among four dealers, compared with the same period of the previous year. And this increase was made at a time of lowest consumption and greatest surplusage. In this campaign, the producers share with the distributors the expense of the advertising and educational work.

You are all familiar with such trade marks as Sunkist, Sun Maid, Sealdsweet, and Jim Hill. They have been indelibly impressed upon your minds solely as the result of advertising. Each typifies a successful accomplishment in advertising and merchandising. But remember that none of these successes would be possible without the cooperative efforts of the California associations of fruit growers. You may be interested in knowing the size of the membership of some of these associations. The Prune Growers' Association has 11,000; the Raisin Growers' Association 15,000, and the Orange Growers' Association a like number. These producers joined hands, not to raise prices, but to save themselves. Before organizing, each farmer stood as an individual and sold against other individuals. If he thought the market was going low, he held off marketing his products. If he thought the market was going high, he rushed his fruit to market, and found that it was fairly swamped with the produce of other individuals. That meant disaster.

The Prune Growers' Association has raised the consumption of prunes in the United States from 47,000,000 pounds to 112,000,000 pounds in a period of three years. The consumption of oranges was increased 300 per cent in a period of seven years as a result of advertising by the California Fruit Growers' Exchange.

You may judge of their faith in advertising by their expenditures. One association appropriated \$2,500,000 to move its 1922 crop. Another will spend \$1,000,000. Two will spend \$500,000 each. And several others will spend amounts ranging from \$300,000 to \$200,000. Besides increasing the consumption of fruit so enormously, the advertising expenditure of the orange growers has decreased the cost of marketing. Ten years ago, the average cost of marketing the orange crop was 5.51 per cent of the delivered value of the crop. And they thought that was low. In 1920, the average marketing cost was only 2.01 per cent of the delivered value of the crop. The saving in one year is almost enough to pay the entire cost of the advertising. It is believed to be the lowest marketing cost of any perishable food product in America.

The capital wealth of these California fruit farms runs into the thousand millions. Advertising has paid off mortgages. Advertising has brought deserved prosperity to California cooperators. And advertising has not raised the prices of their products. If these cooperative associations were not in existence, the farms would be burdened with mortgages. There would be only localized markets instead of national distribution. And what is vastly more to be feared, the grower would be at the mercy of the speculators.

There is nothing experimental in the cooperative association. And there is nothing experimental in the application of advertising to the needs of these associations. The grower knows that it sells his crop, builds his market, gives him assurance and protection, and stabilizes the business of fruit growing. Is it any wonder that the apple growers of the Northwest have taken up the association idea, and that the wheat growers of Manitoba and Alberta are beginning to see that cooperative marketing and advertising might help them? The wheat crop must all be harvested within 12 or 13 weeks. There is the problem of receiving within a few months, a supply of wheat that must be held for use throughout 12 months or more. The assertion was recently made that 8,000,000 men and women are now

directly affected by the success of the cooperative agricultural association in this country.

The dairy industry surely is interested in the success of the advertising campaign for increasing the consumption of coffee. The joint coffee trade publicity committee is spending \$1,000,000 over a period of three years in advertising the delights of Brazilian coffee. The money is raised by a uniform tax collected by the Brazilian Government on every bag of coffee exported from that country. Before launching the campaign, a thorough inquiry was made to determine just where coffee stands in the diet of the American people, and also to discover the best possible means of advancing the sale of coffee through the various branches of the coffee trade.

Other instances of the economic effectiveness of cooperative advertising may be mentioned. The southern sweet potato growers have advertised sweet potatoes. The American Cranberry Exchange has caused cranberry sauce to be served more frequently on American dinner tables, and their success doubtless inspired the Long Island Duck Growers' Association to activity in urging New Yorkers to "put duckling on your tables just a little oftener." There has been a multitude of campaigns for exploiting dairy products.

The figures on the production and consumption of milk in the United States are interesting as showing the great opportunity for cooperative marketing and advertising. The annual production of milk is nearly 90,000,000 pounds. About 44 per cent of this amount is consumed in households. The manufacture of butter consumes about 36 per cent; cheese, $4\frac{1}{2}$ per cent; and ice cream, 4 per cent. The cow population on January 1, 1921, was 24,500,000.

Judging from the success achieved by other organizations, is it not reasonable to assume that cooperative marketing and advertising would promote likewise the prosperity of the dairy industry? You have seen that the public can be educated to a greater use of dairy products. Increased consumption means increased production. That means more cows, more dairies, bigger dairies, increased valuation of dairy farms, and prosperity for everybody in the industry.

Yes, cooperation helps the dairy farmer who does not cooperate. This objection is raised by hard-headed men who do not believe in helping anybody unless that person reciprocates. The answer to that point is that those who do cooperate get enough advantage so that they do not need to worry about those who refuse to cooperate.

THE RUSSIAN DAIRY INDUSTRY.

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Ladies and gentlemen: In presenting this paper to the World's Dairy Congress, we are acting in the name of the all-Russian Union of Cooperatives, briefly called "Selskosoyous," which on January 1, 1923, was composed of 27,500 individual agricultural cooperative associations, representing 2,166,140 individual peasants' farms, and at present, including Ukraina, 4,500,000.

The "Selskosoyous" embraces all kinds of agricultural cooperatives existing in Russia, including those of the dairy industry, namely, the former Union of Siberian Creamery Unions, now reorganized under the name of Siberian Union of Agricultural Cooperatives, entitled

"Sibselkosoyous"; the Peasants' Union of Dairy Associations of Central Russia; the Viatka Union of Creamery Associations of north-eastern Russia; and the Petrograd Union of Dairy Associations, now the dairy branch of the Union of Cooperatives, "Trudosoyous." of the northwestern territory, and others.

The Selskosoyous, uniting the above mentioned regional and local agricultural cooperative unions, represents an economic and moral center of the agricultural cooperatives in general and the dairy industry in particular. In view of that fact, the development of the dairy industry in Russia, in the past as well as in the present, has been and is now connected with the development of agricultural co-operation in general.

GENERAL CHARACTERISTICS OF THE RUSSIAN DAIRY INDUSTRY.

The entire Russian dairy industry is composed of small units, both in regard to the land area occupied by the given farms and to the number of milk cows. At present the average number of milk cows per dairy farm in different sections of the country varies between one and three head. Prior to the war and the revolution the number of milk cows per dairy farm in some localities, as for instance, in the Altai Province, Siberia, averaged five head.

The Russian dairy industry as a whole is primitive, and is connected with grain cultivation and even with the alternating system of agriculture. These forms of agriculture are considerably responsible for the primitive methods of keeping, breeding, and feeding cattle, which result in a low live weight and milk production of the Russian cows. The principal feed of the Russian cattle consists of straw and some hay, and only in exceptional cases are substantial feed and tubers given. As to the keeping of the cattle in Russia, they are generally kept in dark and cold cattle stalls or sheds; for instance, in Siberia cattle are kept under open sheds when the temperature is 35° below zero.

The Russian cattle represent 15 different domestic breeds, which have been developed under specific climatic and feeding conditions. The difference in live weight and milk production is dependent upon these conditions. The average milk production of individual breeds in Russia varies between 740 kilograms and 3,000 kilograms annually, the latter figure representing exceptions, in cases of suburban farms. The general average of milk production per cow in Russia can be taken as 1,000 kilograms annually.

The average live weight of individual breeds of Russian cattle varies between 300 and 480 kilograms, the general average of live weight being 320 kilograms.

The percentage of butterfat of Russian cows among the majority of breeds is very high. In Siberia, for instance, the percentage amounts to 5.3 per cent, and in the Yaroslav district to 4.4 per cent. The yield of butter is proportionately high—the better class of creameries in Siberia obtain 1 pound of butter from every 19 pounds of milk.

Zootechnical experiments and observations have been made for centuries on the better breeds of Russian cows—the Kholmogor, Yaroslav, Okan, Red Colonial, Northern type of Eastern Finnish—and have been partially begun on Siberian cattle.

Productivity and live weight of these cattle depend upon improvements in feeding, keeping, and selection.

TABLE 1.—*Relation between the live weight and the annual milk production of Russian breeds of cattle.*

Breed.	Live weight, in kilo-grams.	Average annual milk production in kilo-grams.	Per cent of butter-fat.
Kholmogor.....	480	4,500	3.7
Red Okan.....	420	4,100	4.3
Yaroslav.....	400	4,200	4.4
Red Colonial.....	390	3,800	4.2
Northern type of Eastern Finnish.....	320	3,000	4.5
Western Siberia.....	280	2,500	5.3

The above breeds represent the foundation breeds of Russian dairy cows upon which, at present, concentrated zootechnical experiments are being conducted.

Besides these domestic breeds of Russian cattle, there is, in European Russia, a large number of varieties of crossbreeds, principally Simmentals, Angels, and Swiss. Crossbreeding represents the method derived from the former Zemstvos (communal administrations), the Government institutions, and private enterprises. This method of improving the breeds of cattle in Russia has now been almost entirely abandoned.

The chief attention of the agricultural cooperatives and the State agricultural administration is at present concentrated upon improving the domestic breeds and creating collective breeding stations for Russian domestic milk cattle. It is necessary to remark here that the domestic types of Russian cattle are almost free from tuberculosis. Tuberculous cattle in Russia are almost a rarity.

The bulk of the Russian dairy industry is connected with cooperative organizations. The cooperative system in breeding milk cattle and producing milk and milk products became a necessity, due to the special conditions of the small peasant farm units, which are crowded in large villages. Small farmers, owning 1 to 3 cows, can not afford to own a purebred sire; nor can they establish a modern creamery or dispose of their butter either on the domestic or the foreign markets. This statement finds confirmation in the history of the development of the dairy industry and the cooperative unions in Russia in general, and especially in the principal centers of the butter making industry, as for instance, in 1903, Prof. A. N. Balakshin, then well known as a communal worker, started a campaign of systematic organization of cooperative butter-making plants. The result was that the number of cooperative creameries grew from 71 in 1904 to 2,200 in 1915, which represented 55 per cent of all creameries then existing in Siberia. At the time of the outbreak of the war, out of 70,700 tons of butter shipped from Siberia to the domestic and foreign markets, 21,045 tons came from cooperative organizations, and in 1916, out of a total of 57,200 tons of butter shipped from the same territory, 47,000 tons, or 92.6 per cent, came from cooperative creameries, the Union of Siberian Creamery Unions.

A similar development of cooperative activity of the dairy industry has taken place in other sections of Russia. According to data com-

piled by Prof. A. Fomin, in 1922, out of 6,127 registered creameries and cheese-making plants in Russia, 5,674, or 92.6 per cent, belonged to cooperative unions, and 2,594 of the latter figure were members of the "Selskosoyous" on January 1, 1923, and of the rest some belonged to consumers' cooperatives, but the majority were "wild" ones, not affiliated with any cooperative organization.

The above number of cooperative creameries does not include the creameries of Turkestan, the Caucasus, the Ukraine, and those owned by small individual farmers. The total number of creameries and cream separators now operating in Russia is many times larger than the number of such establishments, given above as registered in 1923.

The functions of agricultural cooperatives in Russia are not confined to producing and selling of agricultural commodities. In addition to supplying their members with all necessary materials, the cooperatives are assisting the latter in everything pertaining to agriculture in general. So, for instance, the agricultural cooperatives are conducting courses in agricultural subjects; they are contributing to the maintenance of higher schools for cooperation, and to some extent to agricultural schools; they are organizing cattle-breeding stations, operating special farms for producing seeds, etc.

The production of dairy products in Russia is concentrated in small creameries with primitive equipment. The average output of butter by individual creameries in Russia varies in different sections of the country between 2 and 18 tons annually. For instance, in the Altai Province, Siberia, the average annual production of butter per creamery, in 1910, amounted to 16 tons. In European Russia the average annual production of butter per creamery amounts to 4 to 5 tons.

The membership of separate cooperative creameries is from 80 to 450. The average annual milk delivery per cow, in Siberia, is from 150 to 180 gallons, and in European Russia, 300 to 400 gallons. The relatively low delivery of milk is due, primarily, to the low-producing capacity of the cows, and partly, in cases of farmers owning two or three cows, to the consumption of a part of the milk by the farmer's family.

Almost all of the creameries are located in wooden buildings having wooden floors. A typical creamery consists of four compartments: A receiving room, a separator room, a butter-churning room, and an ice house or cold-storage room.

The separation of the cream is always done by means of a cream separator, and the butter churns are operated by horsepower, excepting in very few cases where steam or electric power is used. In European Russia, almost all of the separators and churns are operated by hand, horse or motor driven machinery representing a few exceptions.

Milk is received by the creameries and separated twice daily. The butter produced is mostly salted, and is made from acidified cream. Prior to the war, the cream was acidified artificially, by means of lactic acid bacteria.

The Russian exported butter is distinguished by its high percentage of butterfat, low percentage of water content, and stability. The high percentage of fat and low-water content is due to the application of considerable pressure, which leaves very little water remaining in the butter. Stability is principally due to the methods of feeding and keeping the cows.

It must be taken into consideration that the feed of the milk cows in Russia consists almost exclusively of straw and some hay in the winter and grass in the summer. These rations contribute to the stability of the milk and its derivatives. Apart from the above, three-fourths of the Russian butter is produced in the summer, when the cattle are constantly in the open—in the pastures during the day and under the open sheds at night; even the milking is done in the open. These conditions of feeding and keeping the cows insure a stable milk of good consistency, which is reflected in the quality of the butter.

The quality of Siberian butter, according to tests made by Prof. S. M. Kochergin, is shown by the following percentage of its contents:

	Per cent.
Fat.....	85.59
Water.....	11.58
Salt.....	1.71
Other substances.....	1.12
	<hr/> 100

We shall not dwell upon the subject of characterization of other Russian dairy products, since they are insignificant in the Russian dairy industry when compared with butter.

The scientific research work of the Russian dairy industry is now concentrated in a special educational institution, the Vologda Dairy Institute, and in a number of special laboratories, as well as in other agricultural colleges with special courses on dairy subjects.

Almost all the dairy laboratories have not been functioning during the war, some of them having been entirely destroyed, as for instance, those at Kainsk and Semipalatinsk, in Siberia. The commissariat of agriculture is now giving its attention to the restoration of all the former dairy laboratories and part of them have been entirely restored.

SIZE OF DAIRY INDUSTRY OF RUSSIA AND CHANGES DURING THE WAR AND REVOLUTIONARY PERIOD.

The total production of milk in Russia, exclusive of Turkestan, the Caucasus, and the far eastern region, according to the data compiled by Prof. A. E. Lositzki, amounted in 1916–17 to 14,200,000 tons, or 145 kilograms per capita of population. In 1922–23, the total production of milk fell to 9,680,000 tons, or 105 kilograms per capita.

The total turnover in milk and dairy products in Russia is based on data of railroad transports. More or less correct calculations can be based upon the transportation of dairy products in 1913, the last pre-war year of normal economic life in Russia. The following table shows data compiled by Prof. A. Fomin:

TABLE 2.—*Turnover of milk and dairy products in Russia, 1901 to 1914.*

Year.	Milk.		Butter.		Other dairy products.	
	Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.
1901–1904.....	54,741	100	85,322	100	25,244	100
1905–1908.....	69,290	126	101,435	120	32,161	120
1909–1911.....	74,166	136	118,469	139	41,307	164
1912–1914.....	205,742	375	139,661	169	55,935	208

As seen from the above data, the production and selling of milk and dairy products had been increasing sharply during the last pre-war years. The increase had been particularly large in the consumption of milk by the population of the cities; the quantity of milk transported by the railroads during the last three pre-war years increased 275 per cent. There was also an increase of 107 per cent in dairy products and 62 per cent in butter output during the same period.

About 65 per cent of the annual turnover in butter has been furnished by Siberia, with the northern Provinces next, with 15 per cent, and balance of 20 per cent scattered among all the rest of Russia. The principal part of milk and other dairy products is furnished by the Moscow district, and partly by the northern and northwestern districts. Thus, certain districts can be classified as the centers of milk and dairy products, and it is in these districts where agricultural and dairy cooperatives have been largely developed.

Having established the extent of production and transport of milk and dairy products in Russia prior to the war and the revolution, we may proceed to describe the situation in the Russian dairy industry from the outbreak of the war up to the present time. In order to illustrate the situation more clearly, we deem it advisable to submit the following data pertaining to the changes in the number of livestock in Russia during the same period. The general changes in the number of horned cattle in different Russian Provinces during the periods of the war and revolution were:

TABLE 3.¹—Enumeration of horned cattle in Russian Provinces, 1916–1922.

Territory.	Enumeration in thousands of head.			
	1916	1920	1921	1922
Lake regions.....	1,888	1,645	1,839	2,048
Far north.....	1,001	722	793	816
Moscow industrial district ²	3,084	2,665	2,845	3,039
Central agricultural district.....	5,198	3,792	3,853	3,840
White Russia.....	2,396	2,411	2,414	2,718
Southwestern district.....	2,197	2,593	2,590	2,756
Ukraine.....	2,865	2,844	2,844	2,876
New Russia.....	3,274	2,650	2,650	1,833
Southeast.....	6,111	3,869	3,651	2,849
Lower Volga.....	5,042	3,882	2,577	2,135
Ural.....	6,114	3,910	3,681	2,583
Western Siberia.....	5,625	4,335	3,909	2,912
Eastern Siberia.....	1,361	1,245	1,162	880
Steppes.....	3,807	3,032	1,996	1,766
Total.....	49,964	39,101	36,804	33,021

¹ Data of the Central Statistical Bureau. Figures refer to the best dairy industry regions. Caucasus and Turkestan omitted.

² The Moscow district and part of the lake region have intensive dairy industries.

TABLE 4.—*Number of cows in territories.*

Territory	Per 100 of population.				Per 100 dessiatines ¹ (1 dess=2.7 acres of sown area).			
	1916	1920	1921	1922	1916	1920	1921	1922
Lake regions.....	32.9	31.7	32.1	32.0	71.7	112.5	98.7	93.4
Far north.....	32.2	27.8	28.0	27.5	86.7	107.5	103.6	106.8
Moscow industrial district.....	19.4	20.8	20.6	20.7	49.2	67.0	63.8	59.0
Central agricultural district.....	14.9	20.6	20.7	20.2	20.2	29.9	29.4	26.4
White Russia.....	27.0	27.4	25.9	25.9	39.3	69.4	57.0	52.7
Southwestern district.....	15.1	18.4	17.4	18.2	13.7	18.6	18.7	29.7
Ukraine.....	15.7	16.9	16.7	16.2	21.2	25.9	25.5	25.4
New Russia.....	15.1	21.9	21.9	17.5	23.5	30.4	30.4	31.9
Southeast.....	24.3	22.3	20.9	17.1	18.5	25.0	25.1	25.1
Lower Volga.....	20.7	19.5	15.4	14.1	21.4	26.0	24.1	27.0
Ural.....	26.0	23.3	21.1	18.2	30.9	33.5	33.9	38.5
Western Siberia.....	53.2	37.2	30.7	25.5	57.8	42.1	48.1	59.2
Eastern Siberia.....	43.3	37.1	30.6	25.1	59.5	51.3	67.0	71.4
Steppes.....	36.6	33.7	22.3	37.5	37.5	45.6	42.0	49.4

¹ Increase of cattle on every 100 dessiatines (about 300 acres) depends upon the decrease in cultivated land: in some regions the decrease in cultivated land amounts to 50 per cent.

Table 3 shows that the total number of horned cattle decreased 44 per cent in 1922, as compared with 1916. The largest decrease in that kind of cattle occurred in certain sections of the country where the dairy industry is highly developed, as, for instance, in western Siberia and the Ural region, where the decrease amounts to about 50 per cent of the pre-war figures. In three other sections with a developed dairy industry, in European Russia, the number of horned cattle did not show any decrease, except in the far north; the lake region shows even an increase in the number of horned cattle. The latter facts are of particular importance to the Russian dairy industry, because these districts are now introducing intensive dairy industries. Apart from the above, it is in these districts where the most interesting cattle-breeding experiments have been inaugurated with very valuable specimens of dairy cattle, namely, the Kholmogor, the Yaroslav, and the northern Finnish type. These districts represent a center of breeding of Russian milk cattle.

As a means of restoring cattle breeding, the Commissariat of Agriculture has taken steps both of an agricultural and financial nature as, for instance, the organization of breeding stations, obtaining a special appropriation for issuing loans to farmers for cattle breeding purposes.

THE EFFECT OF THE WORLD WAR, THE REVOLUTION, AND THE CIVIL WAR UPON THE PRODUCTION OF MILK PRODUCTS IN RUSSIA.

This effect can be measured by the following data, showing the quantity of butter received on the market and that collected by the government organs of approvisionnement. The data for butter can be also used as an indicator of the production of milk and other milk products.

TABLE 5.—*Deliveries of butter to the market and collection by the Government.*

Years.	Quantity in tons.	Percentage of 1914.	Years.	Quantity in tons.	Percentage of 1914.
1914.....	134,484	100	1919.....	11,535	8.4
1915.....	126,758	94.2	1920.....	20,643	15.3
1916.....	72,680	54	1921.....	17,742	13.1
1917.....	62,532	46.6	1922.....	24,838	18
1918.....	27,564	25			

It can thus be seen that the production of butter was at its lowest ebb in 1919. There was some improvement in 1920, which was followed by another setback owing to bad crops; however, it did not reach the low point of 1919. The figures for 1919, 1920, and 1921 must be considered critically, because due to the prohibition of private trading which existed at that time, considerable illicit trading escaped registration and could not appear in the statistical data.

THE PROCESS OF RESTORATION IN THE MILK INDUSTRY BEGAN IN 1922.

With the change of the economic policy by the Soviet Government after private commerce was restored in the country, an improvement in the milk industry also took place. So, for instance, western Siberia increased its production of butter from 4,500 tons in 1921 to 6,210 in 1922, or about 40 per cent. A still larger increase has taken place in the production of milk and other products. For instance, the Peasants' Union of Dairy Associations, a very important milk purveyor for the city of Moscow, collected and distributed the following quantities of milk and milk products:

TABLE 6.—*The distribution of dairy products by the Peasants' Union of Dairy Associations 1916 to 1923.*

Year.	Milk, in gallons.	Other dairy prod- ucts, in the terms of gallons of milk.	Year.	Milk, in gallons.	Other dairy prod- ucts, in the terms of gallons of milk.
1916.....	642,000	.....	1922.....	302,100	294,192
1921.....	108,350	53,063	First half of 1923.....	381,000	198,000

As seen from Table 6, the production of milk during the first half of the current year has exceeded the production for the entire year of 1922 and tripled the production for 1921. It must be remarked that the supplying of milk for the large industrial centers has been almost entirely restored in 1923.

Another important cooperative organization, the "Trudosoyous," which is supplying with milk the city of Petrograd, delivered in 1922, 53,826 gallons of milk, and during the first half of 1923, 170,139 gallons. Consequently, the milk deliveries during the first half of 1923 were three times as large as during the entire year of 1922.

A similar increase in milk delivery was shown by the State milk organization "Gosmoloko," one of the largest organizations which is supplying the city of Moscow and other cities with milk and dairy products.

RESUMPTION OF THE EXPORTATION OF RUSSIAN BUTTER AFTER THE WAR AND REVOLUTION.

The improved milk industry and the exportation of butter, the principal dairy product, made it possible to raise the prices of all dairy products, stabilize the market for these products, and stimulate the entire industry. The restoration of the dairy industry has a particularly beneficial effect upon the nonblack soil districts of European Russia and on western Siberia, because upon the development of this branch of agricultural industries depends the welfare and progress of the peasants as a whole.

In the current year, 101,000 tons of butter were expected to be produced and stored in the cooperatives creameries; out of this amount the creameries proposed to export 2,500 tons to foreign markets; 75 per cent of this butter is already collected and stored. Six hundred tons of Selskosoyous butter have already been sold to foreign markets during the current season. This butter was sold in the London market and was found to be of good quality.

The appearance of the Selskosoyous on the foreign markets, even with a limited shipment of butter, will have beneficial results by stimulation of production of butter in Russia and improving the quality of the product.

THE POSITION OF RUSSIA IN THE FOREIGN MARKETS AS AN EXPORTER OF BUTTER.

In order to understand Russia's position in world economics in the dairy industry, it is necessary to consider the following data for the last year of normal economic life in this country, previous to the war and revolution; i. e., the year 1913. Prior to the war, Russia occupied the second place in the world market as a butter-exporting country, after Denmark. The exports of butter of the latter amounted in 1913 to 89,912 tons, against Russia's 77,048 tons. Russia's exports of butter in pre-war times represented 24 per cent of the total world exports of this commodity, and had occupied the second place in the world's markets.

With the development of agricultural cooperatives in Russia and formation of such huge organizations as the Union of Siberian Creameries Associations, the export of Russian butter grew immensely. For instance, in 1899, Russia exported 10,161 tons of butter, and by 1913, the export of butter grew to 77,084 tons, thus showing an increase of 785 per cent since 1899. As a result, the butter-making localities in Siberia, during the last 10 to 15 years preceding the war, had purchased cultivators, harvesting machines, binders, etc., besides dairy machinery—cream separators, etc., of which 20,000 have been imported into Russia.

A considerable number of such machines went out of commission during the war and the revolutionary periods. The major part of butter and cheese making plants will have to be reequipped with new machinery during the next three to five years. The same applies to harvesting machinery, which will have to be replaced. The restoration of Russia's dairy industry can not be accomplished without importing the new machinery.

Therefore, the Russian Central Agricultural Cooperative Union, "Selskosoyous," in considering the question of resuming export operations in the line of agricultural products, including butter, is inevitably confronted with the necessity of importing dairy equipment and other agricultural machinery.

CONCLUSIONS.

In summarizing the above, we take the liberty of presenting the following deductions:

1. The Russian dairy industry which was destroyed during the war and revolution is being restored.

2. The development and restoration of the Russian dairy industry will be followed through the system of agricultural cooperation, which is more compatible with economic life of farmer population, as has been found by past experience.

3. The restoration and further development of Russia's dairy industry depends, on one hand, upon the development of butter exports, and, on the other hand, upon the importation of dairy equipment and other agricultural machinery.

SESSION 20. BUTTER PROBLEMS.

Honorary chairman, Dr. F. E. POSTHUMA, former Minister of Agriculture, Industry, and Commerce, and president, General Dairy Union of Cooperative Dairies, The Hague.

Chairman, T. A. BORMAN, general territory manager, Beatrice Creamery Co., Chicago, Ill.

Secretary, W. L. CLEVINGER, agricultural extension service, Raleigh, N. C.

Y. M. C. A. ASSEMBLY HALL,
Syracuse, N. Y., Tuesday, October 9, 1923—9.30 a. m.

Chairman BORMAN. The meeting will please come to order.

First I must extend to you the regrets of our honorary chairman, Dr. F. E. Posthuma, president of the General Netherlands Dairy Union of Cooperative Dairies, The Hague. The gentleman was here this morning, but has a paper to deliver at another session. As soon as he has discharged his duties there, he will be here.

The first number on the program is "Development of the central creamery," which you will note is to be given by T. A. Borman, general territory manager of the Beatrice Creamery Co. Since I answer that name and description, I will read the paper I have prepared. I am glad it comes first, because those who are not here will not miss much, and those who are here will have an opportunity to get it out of the way before the better things which are to follow.

DEVELOPMENT OF THE CENTRAL CREAMERY.

TOM A. BORMAN, general territory manager, Beatrice Creamery Co., Chicago, Ill.

In the development of the typical central creameries of the American continent, three principles are outstanding:

1. That it is a creamery adapted to the needs of sections of small cow population, or of small production per cow;

2. That to obtain an adequate supply of cream, it must transport cream long distances; and

3. That efficiency and economy in operations are dependent upon the production and marketing of butter in large quantities.

It is believed that the first central creamery was established at St. Albans, Vt., shortly prior to 1895. Its cream supply was centrifugally separated from whole milk at points which had formerly been operated as creameries. This cream was churned at a central point, and thus came the name "central creamery."

The St. Albans practice came to the attention of struggling creamerymen who were endeavoring to operate successfully creameries in Kansas and Nebraska, and it was by them that the central-creamery idea was developed, from which evolution we have the central creamery of to-day. Since the two States named afforded almost simultaneously the home of such creameries, we need refer to the conditions

of soil, climate, etc., which have a direct bearing on the type of agriculture and dairy practice.

The two States, Kansas and Nebraska, are located in almost the exact geographical center of the United States, and constitute an area approximately 400 miles square. The altitude ranges from 800 feet above sea level on the eastern boundary to 3,500 feet on the western boundary at the foot of the Rocky Mountains. The rainfall is torrential, with an annual precipitation of 40 inches on the east, gradually receding to about 14 inches on the west. The winter climate is moderate, but summers are hot and long. The entire area affords good pasture of native grasses, although in the west the grass is short. Farms were large and devoted almost wholly to grain for market and for fattening swine and cattle. Farmers had not learned of adapted methods of cultivation, or of crops adapted to the country, with the result that no confirmed agriculture had developed. There were periods when the population found existence extremely difficult. Farmers under stress of necessity were compelled to milk cows of beefy tendency and breeding, make butter on the farms, and exchange it at the stores for the necessities of life. Large quantities of farm-made butter selling as low as 8 cents per pound were produced. This was for the most part shipped to ladlers and renovators farther east.

This large quantity of butter, made because of the unfortunate agricultural situation, came to the attention of creamery machinery supply houses. Beginning with 1885, creamery promoters organized farmers' stock companies and established more than a thousand creameries in the two States.

Extravagant promises as to the benefits and outcome of these new creameries were made to promote them. When built by farmers with no knowledge of their operations and with no help from any source, such creameries were failures. A few of them fell into the hands of individuals who with capital and knowledge demonstrated in a small way the practicability of making butter in this area: but in every case the volume of milk was so small and uncertain as to make operations difficult and earnings nil. So the hundreds of creameries built with high hopes for success and prosperity continued inoperative.

It was amid such conditions that the St. Albans, Vt., central-creamery idea was transferred to the Middle West. Creamerymen of vision and strong hearts established creameries equipped with the best of machinery then available, at favorable central locations, and, acquiring the defunct creameries and converting them into "skimming stations," began to make butter. The initial creamery failure bred suspicion among farmers, and their response in milk offered was none too prompt or profuse. Anyway, when prospects were good for grain, milking was neglected.

The labor and expense of delivering to the skimming plant whole milk daily at distances as high as 25 miles was not looked upon favorably and was discontinued when Providence promised good crops. The central creamery had not yet afforded the convenience nor shown the permanency which the farmer required to make him a dependable supplier. But the idea stuck, and these same men of vision constantly sought improvement.

It was during the years from 1900 to 1905 that the centrifugal farm cream separator came into practical use, and its general adoption by the farmer established the central creamery on its present basis. Creamerymen introduced the separator and financed farmers in its purchase. The farmer could now see a way by which his objection to producing and marketing milk could largely be overcome. He could see how the expense of delivery could be reduced in handling the smaller volume of cream compared with milk; how few trips to the market could be made; how he could have more time in his field, and how much more valuable the warm skimmed milk would be for his livestock than the cold and sour skimmed milk from the skimming plant.

It is to be kept in mind, however, that the farmers were not dairymen. They had migrated west to grow wheat and corn and feed cattle and swine and, not having the expected prosperity following, were milking cows only because of financial stress and emergency. This thought you will keep before you, together with the fact that the American farmer is not from antecedents or choice a farm dairyman. However, it is a fact that the farmer of the central-creamery territory is seeing more and more the advantages of farm dairying; and it is to be expected that as time passes changing conditions in agriculture will impress him to the point of becoming a dairyman in fact.

Completing this picture of the birthplace of the central creamery, we must add that in 1917 the cow population per square mile was 9, and butterfat sales per annum $177\frac{1}{2}$ pounds; the cows per farm 4.1, and the butterfat sales per farm 82 pounds. Compare the same, please, with Wisconsin, our leading dairy State, which had $26\frac{1}{2}$ cows per square mile, sold 873 pounds of butterfat per square mile, with 8.3 cows per farm and 272.4 pounds of butterfat per farm. In other words, it would require a territory five times as big in Kansas and Nebraska to yield a quantity of butterfat equal to that of a given territory in Wisconsin. Wisconsin lies north of our corn and winter-wheat belt, and is our leading dairy State in point of output. In this connection, however, to show the agricultural tendencies of each State, let it be known that Kansas ranks second of the States of the Union in value of wheat, corn, swine, and beef cattle, and sixth in dairy output; while Wisconsin stands first in dairy output and eleventh in value of wheat, corn, swine, and beef cattle.

It was in this atmosphere and under these conditions that the central creamery of to-day was established, and from which the central system of creamery operation has radiated to all States in which similar general conditions exist. The picture fits all the territory west of the Mississippi River, except portions of California, Washington, and Oregon; and all this is central-creamery territory in the strictest sense. But, practically all other States, and among them the leading dairy States, into which the use of the farm cream separator has come, have adopted the central-creamery system. It may be said that the central creamery has followed the farm cream separator.

The cream supply of central creameries is obtained through one of the following three methods or combinations thereof:

1. Through cream-receiving stations located at rail stations convenient for the farm dairyman, at which receiving stations each

delivery of cream is immediately paid for. This is the "cream station" plan. In every instance the cream station has the facilities required for accurate weighing and Babcock testing of cream. The character of equipment varies greatly, ranging from boiler for hot water and steam to a stove; and from steam or electric-driven tester to a four-bottle hand tester, in either case depending upon the volume of cream available. Stations of largest volume are operated by men who devote their time to the purchase of cream exclusively. Stations of small volume are nearly always in the hands of some one who has some other line of business. A cream station is regarded as an aid in securing patronage for other business.

Every village insists upon having a cream-buying station and frequently several, thus inducing the farmer to sell his cream and spend the money there. Prices paid by the buyers are quoted by the creamery on market changes. Deliveries are made at the convenience of the farmer, usually at a time when he finds it necessary to go to town for other purposes, either business or pleasure. In the busy season the women or children make the deliveries. The cream from stations is usually shipped by rail to the creamery. Ten-gallon shipping cans are used, and the average rate for transportation is equivalent to $1\frac{1}{2}$ cents per pound butterfat for a distance of 100 miles. It is a conservative estimate that 75 per cent of the central-creamery supply of cream is obtained through cream-buying stations.

Most States regulate the cream-buying stations by statute, requiring sanitary station surroundings and cleanly handling, and also requiring buyers to pass an examination showing proficiency in Babcock testing. All States require certain standards for test bottles, testers, etc., and some specify character of room or building used for buying. All States enforce regulations through a dairy commissioner or other department employing inspectors.

2. Another source of butterfat supply is cream shipped by rail by the farm dairyman in his own can directly to the central churning plant, his check being mailed for each delivery, and the shipping can returned by rail. This is known as the "direct shipping" plan. This system affords market for the farmer who is not within reach of a cream-buying station, but who can get to a railroad. There are many producers also who are willing to attend to the details of delivery to the transportation company, and who can wait a few days for the return of their checks by mail, who avail themselves of this plan. It has been estimated that 25 per cent of the producers have cream sufficient in quantity to make direct shipping possible; i. e., sufficient cream of from 30 to 35 per cent butterfat to forward in a 5-gallon can at least twice a week. It is estimated that about 15 per cent of the central-creamery butter is produced from cream obtained through this method of collection.

The station and direct-shipping plans, or combinations of both, are employed exclusively in the sections of large farms and small cow population.

3. But the central creamery has found its way into the older and more highly developed dairy sections. While in these States station buying and direct shipping are both employed, the "route system" of gathering is well established and successfully maintained because of the smaller farms, the greater cow population, and all-year usable

roads. The route system is that of collecting cream at regular intervals at the farm of the dairyman, and employing either wagon or rail transportation, or both, to the creamery. With the route system, the farmer's cream is sampled at his door, tested at the creamery or a central testing point, and the check in payment delivered on the following gathering day. In summer cream is usually gathered twice a week, and during winter, once.

The fact must appeal to the hearer that in each of the three systems of gathering cream is the element of the outstanding need for meeting the dairy farmer's convenience. In other words, in the grain and stock belt, he produces cream for sale only when he can market it at a minimum of expense and trouble, and at the same time secure quick returns. He is opposed to restrictions as to frequency and time of delivery, special care of the cream, etc., and will continue in this frame of mind until necessity compels farm dairying as a business, not as a side line to general grain and stock farming. The United States Department of Agriculture estimates that 85 per cent of the dairying of this territory is done as a side line or incident to general farming.

The volume of cream per delivery by both station and route plan is small, depending upon the number of cows per farm and the distance to market, and the consequent frequency of delivery. It ranges from 8 to 80 pounds. The small producer is in the majority at all times. Likewise, the cream varies greatly in percentage of butter-fat, percentage of acidity, and flavor. Some is skimmed by gravity and by centrifugal separators which will not produce a heavy cream. The acidity and flavor depend upon the farm facilities for cooling and the extent to which they are used, the distance to market, the frequency of delivery, and the condition of utensils in handling. The flavor is governed by the above, but also is influenced by season and pasture conditions. In most instances the farmer does the best he can to produce good cream, according to his ideas.

Creameries have been for years endeavoring to secure State regulations regarding cream quality and grading of the cream. Only one State, Oklahoma, has a cream-grading statute. This law is a dead letter because of its very high requirements, and its enforcement would destroy the industry in that State. Cooperative efforts among creameries have been attempted; and while some good has been accomplished, no concerted effort affecting a large area has produced marked results. In all of these attempts, which have had the moral support of State dairy authorities, first-grade cream has been designated as "cream which is clean, smooth, free from all undesirable odors, clean to the taste, and sweet or only slightly sour." Second-grade cream has been described as "cream which is too sour to grade as first, that contains undesirable flavors or odors in a moderate degree, that is foamy, yeasty, or slightly stale, or that is too old to pass as first-grade."

Of the above grades, the percentage of each received at the creamery will vary with the season of the year, but will average 80 per cent of first-grade cream for station-buying creameries. The percentage will probably run higher for both direct-shipper and route-gathering creameries.

Under the agricultural conditions and the attitude of the farmer as described, the central creamery has been builded and developed. Figures definitely setting out the volume of butter made by central creameries are not available, but there is good reason to believe that more than one-half of the factory-made butter of the United States is produced by them, approximately 577,000,000 pounds. This is the development of the central creamery in less than 30 years. That development has brought the advantages of farm dairying to hundreds of thousands of farmers in territories in which previous methods of creamery operations had failed.

Incidentally, it was important for the central creamery to develop methods, and machinery as well, for its economical handling of this new product—farm-separator cream—and for making from it a quality of butter which would enter the commerce at a price which would permit the largest possible return to the producer of the raw material, and which would also meet the requirements of the consumer. The problem at hand demanded the attention of the best minds in factory, dairy school, and experimental station. Together these set out to solve the problem, and individually and collectively they have done well. They met the emergency which the producer had put before the dairy industry.

Out of this product of the farm, and out of the skill and energy of those connected with the industry, came the quality of butter which is listed in our market quotations as “standards”—a grade which requires a score of 90 points.

There has come into our merchandising of butter the principle that butter value be measured by the usefulness of the butter. Like all other commodities, butter is in demand according to its usefulness—the satisfaction it gives the storer, the dealer, the distributor, and the consumer when the last of a purchase has been eaten. This usefulness is measured by several requirements: Palatability, uniformity, availability. Butter that is very good sometimes and not so good other times is not satisfactory, because the periods of better quality only help to emphasize, by contrast, the periods of poorer quality. A butter of good average quality, but uniform, gives the best satisfaction. Keeping quality is an important element of butter quality which is very difficult to produce, but which follows the extreme pains in control of acidity and Pasteurization practiced by the better class of central creameries. On the point of availability, a butter which is unreliable or inadequate in supply is not long in demand.

Because of its uniform good quality and dependable supply, these points reflecting its usefulness, central-creamery butter of the “standards” grade is in good demand. These characteristics are produced as follows: To provide a dependable supply, large volumes of cream are purchased. This cream is of the best quality obtainable for that volume. Every possible effort is made at all times to improve and maintain the quality of this cream. When it arrives at the creamery, it is carefully graded by skilled men, and the best portion of it is made into so-called No. 1 butter, or “standards.” The poorer portion is made into an undergrade butter called No. 2. All mechanical operations require extreme care in every operation, and in the central

creamery these are maintained to a high degree of skill. Creamery and equipment are maintained at a high standard of sanitation. The grading of cream, as stated, is skillfully done. Neutralization is effected uniformly in the minutest detail. Pasteurization is 99.99 per cent perfect. Cooling, churning, washing, salting, and working are each done with a precision which insures uniformity day after day and year after year. All these processes are controlled by suitable recording thermometers, and bacteriological and chemical tests are made in laboratories, the latter being as necessary to the best-equipped central creameries as a churn. To summarize, the important steps in producing a dependable volume of useful butter are: A sufficient volume of good cream, intelligent grading, proper neutralizing, efficient Pasteurizing, sufficient washing, and uniform working.

Nearly every article of commerce could be made better. To make it better increases the cost of production and often curtails the volume. When, as a result of high cost, the price gets too high in relation to usefulness, the demand decreases.

Nearly every article of commerce could be made poorer. This usually makes production cheaper, price lower, and larger volume possible. When an article becomes so poor its usefulness is impaired, demand decreases.

For every article there is a relation of cost and usefulness at which demand is greatest, and the central creamery has with its "standards" grade of butter been able to produce for the industry and the consuming public a large volume of dependably useful butter.

A large part of the central-creamery make of butter is packed in bricks called "prints" of one-pound, one-half pound, and one-quarter pound size at the creamery. The proportion of each size is regulated by the consuming public, which seeks a convenient package. The bricks are wrapped in parchment paper and then covered with a paraffined carton—a paraffined pasteboard box. Some creameries use coverings consisting of parchment paper, paraffined paper carton, and decorative label in the order given. Both cutting and wrapping are largely done by machinery.

In its most highly developed form, the central creamery is a marketing agency for its own output, and as such has solved many heretofore perplexing problems to the consumer's esthetic and economic satisfaction. Through its distributing agencies, receiving regular supplies by the most favorable methods of shipment, and of storage while on hand, through regular deliveries to the trade—these features and others succeeding the hodgepodge methods of middlemen and butter cutters with hit or miss delivery systems—the central creamery at a minimum of expense but with an unexcelled service places butter in the consumer's hands in the best possible condition.

The central-creamery system evolved from an actual need in a large area of our country. It grew out of the trial by the grain and livestock farmer of every then known method of creamery operation, which had all failed to meet his requirements. While originally its purpose was that of providing for the producer of cream a permanent and satisfactory outlet for the product of his dairy, it was not expected that for the consumer it would prove an equally great

benefiting factor; but the latter is a logical sequence and conclusion, for no commodity has a value unless there are users or consumers for it.

Hence, the function of the central creamery does not close with the making of butter, but continues to the point where it finds or makes a market for its goods.

Chairman BORMAN. Gentlemen, on account of the length of the program, we will defer any discussion on this paper until such time as we may later have for consideration of it.

"Some factors relating to the production of cream for butter making in New Zealand," by W. Dempster and G. M. Valentine, dairy instructors in the Department of Agriculture, New Zealand, is the next number. Since neither of these men is present, we will have our secretary read the paper after the papers presented by those authors who are present.

According to the rules of the congress, when the author is not present to read his paper it will be deferred until the end of the program.

The paper following is, "The commercial significance of the variable constituents of creamery butter," by J. R. Keithley, professor of dairy husbandry, University of Minnesota. Mr. Keithley is not here, so his paper will have to be deferred.

Have we anyone here to read the paper of Dr. Otto Rahn? If so, we will take that up later.

The next paper is, "The importance of the equilibria in the system milk fat in the making of butter," by Dr. W. van Dam, director of the chemical department of the State Agricultural Experiment Station, Hoorn, Holland. Is Doctor van Dam here? It appears he is not.

The Swiss dairy film at the Strand Theater, which has robbed us of our honorary chairman, has undoubtedly robbed us of some of our speakers.

I believe Professor Sommer has had to leave for a short while, but will be back soon. In the meantime, we will proceed to the next paper, "The influence of salt on the flavor of butter," by A. C. Dahlberg, chief of the division of dairying, New York Agricultural Experiment Station, Geneva, N. Y. [Applause.]

THE INFLUENCE OF SALT ON THE FLAVOR OF BUTTER.

A. C. DAHLBERG, chief, division of dairying, New York Agricultural Experiment Station, Geneva, N. Y.

The practice of incorporating some salt in butter is almost universal. Salt is a seasoning for butter; it removes the insipid taste of unsalted butter and gives a pleasing flavor that is relished by most people. If salt produced no other effect in butter than that of seasoning, the problem of the influence of salt on the flavor of butter would be comparatively simple. The indirect effects of salt on flavor, due to its influence on the composition of butter, the microorganisms, enzymes, and slow spontaneous chemical changes, complicate the problem and make it difficult of solution.

COMPARISON OF VARIETIES OF SALT UPON FLAVOR.

It was but natural that early investigators should have concerned themselves with a study of the effect of various kinds and qualities of salt upon the flavor of butter, for they knew so little about the other problems. The early trend of thought regarding salt in butter as a seasoning agent is illustrated by the following quotation from one of the first dairy books published in America, that by Flint (1866) :

* * * the greatest care is required in the salting or seasoning. Over-salted butter is not only less palatable to the taste, but less healthy than fresh, sweet butter. * * * most dairy women determine the quality of salt by the eye and the taste, and acquire such facility by continual practice that they always get the proper quantity; but less experienced ones take the salt by weight.

The desirability of a uniform salt content in butter was recognized at that time. Flint also states that "Ashton" salt should be used and that "western" salt should never be used as it injured the flavor. No reason was given for this discrimination, but a difference in salt was recognized. Lynch (1883), in his *Manual of Scientific Buttermaking*, states that "salt should be pure; yet pure salt in the market is the exception rather than the rule."

During the period prior to 1890, a very limited amount of research work had been done on salt and butter. The methods of manufacturing salt did not give as high a percentage of sodium chloride as the dairy salt of to-day contains, and impurities in some brands of salt could be easily detected by their bitter flavor and insoluble condition.

Kent and Leighton (1895), working with six brands of American dairy salt, were not able to differentiate between the flavors they produced in butter five weeks after it was manufactured. Some difficulties were encountered in Europe with dairy salt, and in Germany a bitter flavor in butter was reported by the Chamber of Agriculture, Province of Posen, 1898, to be due to magnesium sulphate in the salt. A thorough study of dairy salt was undertaken by Woll (1898), and detailed chemical and physical analyses were made of a large number of American and European dairy salts. Woll states that magnesium and calcium compounds had bitter flavors and were responsible, especially when present as chlorides, for the absorption of water and hardening of salt when stored in a moist atmosphere. He found American dairy salts to contain 98 to 99 per cent sodium chloride, and to be so low in impurities that he reasoned their effect on the flavor of butter must be nearly identical. European salt was of poorer, more variable equality. Although other investigations on the purity of salt, in particular that of Hesse (1906), have been undertaken since the work of Woll, the fundamental understanding of the relative value of good dairy salts has not changed. So far as flavor in butter is concerned, they are all considered of equal value.

EFFECT OF SALT UPON MICROORGANISMS IN BUTTER.

The influence that salt may have upon the flavor of butter, due to its effect on the growth of microorganisms, has been a difficult problem to solve. That salt inhibits the growth of microorganisms was easily and repeatedly demonstrated, but it has proved difficult

to connect microbial growth or reduction in numbers with any chemical and flavor change.

It is not within the scope of this paper to discuss the general effect of microorganisms on the flavor of storage butter, but some understanding of this is essential to a closer knowledge of the influence of salt upon flavor as affected by microorganisms. Duclaux (1887) found that oxidation was the chief cause of deterioration in the flavor of storage butter. Ritsert (1890) also considered these flavor changes as being caused by purely chemical phenomena and excluded the possibility of microorganisms by their failure to grow in butterfat.

Anther (1899) believed rancidity to be partially due to chemical changes produced by bacteria. Jensen (1902) isolated organisms that he associated with off-flavors in storage butter. O'Callaghan (1902) concluded that *Oidium lactis* was the cause of fishiness in Australian butter. Fettich (1908) noted a marked reduction in microorganisms in salted butter, but unsalted butter showed this decrease about 30 days earlier.

The work on this problem was started in America by McKay and Larsen (1903). They state "that cheesy flavor is partially produced by the ordinary green mold, the writers are not in doubt about, for in every instance where little or no salt had been used the butter became moldy in a comparatively short time and assumed that cheesy flavor and aroma." Rogers (1904), working with canned butter, excluded bacteria as a cause of increased acidity in butter which he associated with off-flavors. Later, he with Gray (1909), concluded that microorganisms could be identified with the off-flavors produced in butter as a result of high acid in the cream before churning. Sayer, Rahn, and Farrand (1908), whose work was continued by Rahn, Brown, and Smith (1909), found that organisms in salted storage butter decrease rapidly in numbers, although not as rapidly as in the unsalted butter, but a few may develop under these adverse conditions. Their findings, that bacteria in unsalted butter in cold storage decrease more rapidly than in salted butter, were later confirmed by Washburn and Dahlberg (1917).

Brown (1912) reported to the Society of American Bacteriologists that 24 out of 57 bacteria isolated from butter, and 15 out of 31 yeasts, were able to grow at a reduced rate in 12 per cent salt at 20° C. Similar results were obtained by Giltner and Baker (1915), who found that eight per cent salt interfered with the growth of most organisms and that a few grew in a 20 per cent salt solution.

The recent work of Supplee (1919) associates a definite bacteria, *Bacterium ichthyosmius* Hammer, with a specific flavor (fishy); and, while the organism always produced the fishy flavor, all fishy butter did not contain the organism. Salt seemed essential to the production of the flavor. Cusick (1919) obtained similar results.

It is evident from this review of the literature that the final solution of this problem is yet to be discovered. Results to date demonstrate the following as being the probable effects of salt on the flavor of butter as affected by microorganisms. Salt is antiseptic in the concentrations usually found in butter. Microorganisms of certain types grow in butter held above freezing temperatures, and their growth may result in off-flavors in the butter. This growth and the

subsequent development of off-flavors at warm temperatures is checked by salt, and salt then proves beneficial to the flavor of butter. If the butter is held below the freezing point, nearly all microorganisms fail to develop, and, with the possible exception of the work of Supplee and Cusick, no definite relationship between their growth and off-flavors has been established. Their importance in storage butter is probably minor, as demonstrated from negative evidence, although definite proof of this statement is lacking.

EFFECT OF SALT UPON CHEMICAL CHANGES IN STORAGE BUTTER.

In addition to the effect that salt exerts upon butter through its influence upon microorganisms, it has a direct bearing upon spontaneous chemical and enzymic changes in butter. The off-flavors in butter are necessarily chemical products of some nature, no matter what the cause of the off-flavors may be. Some of the first research work on the flavors produced in storage butter showed an absorption of oxygen upon exposure to air and light and an increase in acidity. Studies correlating salt with chemical changes are comparatively recent.

Rogers (1904) associated the increased acidity of canned butter with its depreciation in score, and stated that this chemical change was caused by a lipolytic enzyme. Its action continued in spite of the salt concentration usually found in butter. Working with Gray (1909) they concluded that fishy flavor was due to a slow spontaneous change brought about by the action of oxygen and light. Rahn, Brown, and Smith (1909) were unable to correlate increased acidity with the development of off-flavors. They favored the view that an increase in "amid nitrogen" was an indication of the development of off-flavors, and showed that salt retarded this increase. Similar results were obtained by Fischer and Gruener (1911). Continuing their own work, Rogers, Berg, Potteiger, and Davis (1913), by the use of new methods, obtained results contradictory to those of Rahn, Brown, and Smith, in that no proteolytic action was discovered in storage butter, but they also found that salt completely inhibited proteolytic enzymic activities at usual butter storage temperature when the enzyme was present in small quantities. In their study of the catalytic effect of iron on flavor, its action was lessened by an 18 per cent salt solution. Larsen, Lund, and Miller (1910), in an attempt to associate acid development in butter with the production of off-flavors, stated that "the effect of salt on the keeping quality of butter was also plainly shown in the greater amount of acid developed in the low salted butter."

The activity of small amounts of proteolytic enzymes was checked by 18 per cent sodium chloride and 0° F., according to Berg (1912), but these conditions did not prevent activity of increased concentrations. Washburn and Dahlberg (1917) also showed that salt inhibited the increase in acidity in storage butter, but they did not find any relation existing between increased acidity and score. They noted that all of their salted butter in storage eventually became fishy, but this flavor did not develop in any unsalted butter. Thatcher and Dahlberg (1917) found that the fat of butter dilutes the enzymes to so great an extent that the salt brine and cold temperatures of

storage butter exclude the probability that enzymic activities may play a major rôle in cold-storage butter. Supplee (1919), in studying the probability of the decomposition of lecithin into trimethylamine to produce fishy flavor in butter, learned that salt accelerated the action. Cusick (1919), working at about the same time as Supplee, obtained similar results, and Sommer and Smit (1923) have more recently verified these findings.

Any attempt to summarize the work on the effect of salt on the flavor of butter, as affected by chemical changes, must recognize the fact that our knowledge is very inadequate. It has been proved that salt checks the rate of increase in acidity of butter during storage, as well as oxidation, proteolysis (if any such action takes place), and enzymic activities. Whether any relationship exists between these changes and the development of off-flavors is very doubtful. The inhibitory effect of salt on the catalytic action of ferrous compounds should result in a distinct advantage to the keeping quality of butter. The acceleration of the conversion of lecithin into trimethylamine, or fishy flavor, by salt, as shown by Supplee (1919), agrees with the previous experience of some investigators and butter storage merchants that salt tends to produce fishiness in butter.

THE FLAVOR OF SALTED BUTTER IN STORAGE.

During the first few days after churning, the flavor of butter changes markedly. It loses that freshly churned taste and acquires its permanent butter flavor. The experience of practical creamery men seems to favor the view that a low salt content of 2 to 2.5 per cent is conducive to the highest quality initial flavor. "Oversalted butter is always butter of inferior quality," wrote Lynch in 1883; and although this statement was in dispute for some years, its truth has become established during the past 10 years. The delicate fine flavor of a high-quality butter, made from fresh sweet cream, is hidden by excessive salt, while the flavor defects of poor butter, made from old, sour, defective cream, are intensified by it. Butter manufactured from cream, to which a good quality starter has been added, often improves in flavor for the first week or two. This is especially noticeable in neutralized-cream butter, and it is apparently intensified by a low percentage of salt.

The effect of salt upon the flavor of storage butter has been the subject of many investigations. Seidl (1892) obtained results indicating a preserving effect of salt. McKay and Larsen (1903) concluded that "salt improves the keeping quality of butter." Dean and Harcourt (1905), working on butter preservatives, stated that for home trade no other preservative than salt was needed. Gray and McKay (1906) stated that butter containing low percentages of salt kept better than did butter of the same lot containing higher percentages of salt. Sayer, Rahn, and Farrand (1908), as well as Rahn, Brown, and Smith (1909), found salted butter to keep better than unsalted, above the freezing point as well as below. Larsen, Lund, and Miller (1910) conclude that salt has a great preservative effect. Fischer and Gruenert (1911) found salt to be the best preservative of all the chemicals they tried. Crowe (1913) reported that unsalted butter scored higher after five weeks storage than did salted

butter. The results of Hunziker, Mills, and Spitzer (1912) favor the light-salted butter in preference to heavy-salted butter. Washburn and Dahlberg (1917) found unsalted butter to keep much better than salted butter, in and out of cold storage. After 284 days at -15° F., they found all the butter to be low in bacterial content and the percentage of *Bacterium lactis acidii* to be especially high. When this butter was then stored at a warm temperature, the unsalted butter increased in acidity and the bacteria grew more rapidly than in the salted samples, but the flavor of the unsalted butter remained the better of the two. Supplee (1919), Cusick (1919), and Sommer and Smit (1923) found salt to hasten the production of fishy flavor.

A definite conclusion on the effect of salt on the flavor of storage butter can not justly be drawn from research work alone. The literature is full of contradictions, but the tendency of recent work points toward the conclusion that "salt, exclusive of its antiseptic property, hastened the deterioration of the butter" in cold storage, as stated by Washburn and Dahlberg (1917). This view is in accordance with the experience of butter storage merchants who wish a mildly salted butter for storage purposes.

SUMMARY.

Modern cold storages for butter maintain a temperature below 0° F., and this temperature is very effective in inhibiting bacterial growth. Salt, therefore, is not essential for this purpose. However, if butter is stored for any period of time in ordinary refrigerators at temperatures above 0° F., salt preserves butter against the deleterious effects of certain microorganisms. Although salt checks the acidity of butter, there seems to be little or no relation between the increasing of acidity in butter and its flavor. The inhibitory effect of salt on enzymic activity of lipases and proteases must be of minor importance since no experimental data have proved a definite relation between such action and the flavors developing in butter. The question in its final analysis must be: Has salt a deleterious effect on the flavor of butter, irrespective of its effect on other chemical or bacterial changes? The answer, although all evidence is not in agreement, must be in the affirmative. Research in recent years has demonstrated that unsalted butter keeps better than salted, and that lightly salted butter keeps better than that which is highly salted.

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Chairman BORMAN. Are there any delegates present who desire a digest of these papers in German, Spanish, or French? If not, Professor Dahlberg's paper is now open for discussion for about 10 minutes.

Dr. H. W. REDFIELD (Bureau of Chemistry, Department of Agriculture). I was wondering whether information that was brought out at the last meeting of the American Chemical Society

would bear upon this subject. A paper was presented to the effect that these unknown substances, vitamins, that we have been talking about so much in the immediate past really depend on the presence of certain metals among which are copper, nickel, magnesium, etc. Work has been done by Mr. Hunziker, published by him, also by Doctor Supplee, showing the effect of the presence of copper, which is one of the normal ingredients, on the keeping quality of butter and dried milk.

Magnesium is another one of these metals which is supposed to act by chemical action on vitamins, and I am wondering whether the amount of magnesium present has an effect on the keeping quality of butter.

I imagine most of those experiments reported by Professor Dahlberg were made with commercial salt, not with the pure chemical salt. I am wondering whether the variations he mentioned may possibly have been due to differences in the amount of magnesium carried as an impurity and, therefore, to the degree of chemical action which we would have, due to that impurity.

Mr. DAHLBERG. That matter of metals has been worked on. I believe Doctor Rogers was one of the first to work on that in the United States Department of Agriculture, back about 1904. He found a very marked effect, particularly in relation to iron, in the rate at which butter deteriorated in quality. I believe, though, he did not find that if he kept his butter free from the iron and other salts that deterioration stopped. It was a matter of hurrying it up rather than entirely stopping. Of course, the matter of the amount of these impurities in salt has never been worked out in detail, and we don't know with reference to that.

One of the biggest factors, I think, in giving all these analyses has been that the quality of the cream, together with the sorts of micro-organism in it before churning, has not been carefully compared with other work. There has also been a difference usually in storage temperature. Some workers, for instance, have held all their butter at about 50° F. as a matter of determining keeping quality; others at 10° or 15° below zero. I don't believe those two are comparable at all on account of the fact that there may be microorganisms in the butter that would grow at 50°; whereas at 10° below zero they may not grow at all.

Mr. O. F. HUNZIKER (Blue Valley Creamery Co., Chicago). Mr. Dahlberg has shown that unsalted and lightly salted butter keeps better in cold storage than heavily salted butter. This, as has been explained, may be very largely due to chemical action resulting from the presence of salt. If biological action has anything to do with the effect of salt on the keeping quality of butter in cold storage, then is it not probable that the difference in the freezing point between brine and water may exert some influence? In unsalted and lightly salted butter, the freezing point of the moisture in butter is far above the temperature of commercial cold storage. Hence, the water or dilute brine freezes soon after the butter enters the cold storage and therefore becomes immune to bacterial life and action. In the case of the heavily salted butter, the freezing point of the brine is or may be as low or lower than the cold-storage temperature. Hence, the brine does not freeze. It remains liquid and offers favorable condition to those bacteria that are capable of thriving in brine.

Hence, heavily salted butter in cold storage may be subject to bacterial action.

I am very much interested in the suggestion made by Doctor Redfield that the presence in butter of magnesium resulting from the use of impure salt may have a great deal to do with the deterioration of butter. I believe in this possibility as far as the effect of magnesium lime neutralizer is concerned.

Our investigations showed that very little, if any, of the magnesium of the neutralizer becomes a part of the butter, and we have been forced to conclude that the magnesium of the neutralizer is a negligible factor from the standpoint of flavor and keeping quality of the butter.

Chairman BORMAN. Are there any further remarks with reference to this paper?

Doctor REDFIELD. In the manufacture of neutralized cream butter the most magnesium goes into the buttermilk; whereas, if you put it in the form of impure salt it stays in the butter. My idea was not so much that it was a matter of inducing chemical action directly as indirectly through exciting biological action.

Mr. A. POOLE WILSON (chief inspector of dairying, Dublin). Some one has asked if chemically pure salt has been used for salting butter. A good many years ago in Ireland we were investigating this same problem, and we used chemically pure salt prepared by ourselves, as pure as it was possible to get it, synthetically made. We also used salts to which we added various quantities of magnesium, chloride, sulphate, and so on. The result of our experiment was, briefly, this: That the quantity of magnesium salts as found in our ordinary commercial salts had no effect on the butter, and the pure salt had the worst effect. The same butter in all cases was salted, and invariably the butter salted with the chemically pure salt scored lowest. That was after storing it at cellar temperature for three weeks—the ordinary length of life of butter shipped from an Irish creamery in the summer months, a week with the wholesaler, a week with the retailer, and a week in the home. The pure salt gave the worst results.

Chairman BORMAN. The time is now up for discussion of Professor Dahlberg's paper. However, should we have time after the other papers have been read you have the privilege of again referring to this paper and discussing it.

The next paper is "The action of the organisms present in the starters used in butter making," by Prof. B. W. Hammer, of the Iowa Agricultural Experiment Station. Professor Hammer is not here, but the secretary has his paper and it will be taken up later.

I find that Professor Sommer is now here and will read his paper. Professor Sommer.

FISHY FLAVOR IN BUTTER.

HUGO HENRY SOMMER,¹ Ph. D., assistant professor of dairy husbandry, College of Agriculture, University of Wisconsin, Madison, Wis.

At times there occur in butter a flavor and odor designated as "fishy." "Fishiness" hardly needs any further description: it resembles the flavor and odor of mackerel, salmon, or herring. It is

¹ The greater part of the experimental work reported in this paper was performed, under the direction of the author, by Mr. B. J. Smit, in partial fulfillment of the thesis requirements for the degree of doctor of philosophy, University of Wisconsin.

detected and considered repulsive by even the most casual consumer: and because of this, it lowers the price of the butter from 3 to 5 cents per pound.

Fishiness hardly ever occurs in fresh butter; it is primarily a storage defect, occurring in storage and export butter. It is found in butter exported from Australia, New Zealand, and South Africa, and it is known to occur in the United States and Canada. Some writers are of the opinion that fishy flavor causes greater losses in butter than any other one defect.

The economic importance of this defect is indicated by the number of investigators who have studied the problem. Since this flavor was first noted by Storch (1) in 1890, some 60 papers have appeared dealing directly or indirectly with this problem. The investigators have concerned themselves mainly with the conditions that favor and the agencies that produce fishiness; comparatively little has been done to identify the compound imparting the fishy flavor and to determine its mother substance.

A number of investigators have studied the conditions that favor the development of fishiness, and, in general, there is agreement. The common conclusion is that fishiness is favored by high acid, high salt, overworking, and the presence of iron and copper salts.

The investigators who have studied the agencies which produce fishiness are divided into two schools, first, those who hold that it is caused by biological agencies; and, second, those who hold that it is the result of a slow, spontaneous, chemical change.

In general, the evidence in favor of the biological theory is not conclusive. Attempts to develop fishiness by bacterial inoculations into the butter have failed. The salt in the butter inhibits the growth of bacteria, yet fishiness occurs mainly in salted butter. Due to these considerations Rogers (2) eliminates the idea that biological agencies are the cause.

Rogers (2) then attributes the development of fishiness to a slow chemical oxidation; Reakes, Cuddie, and Reid (3), and Dyer (4) are of the same opinion.

Comparatively little has been done to identify the fishy compound and its mother substance. Trimethylamine was suggested by Sommerfeld (5) as the fishy compound in the butter; and Supplee (6) and Cusick (7) have presented experimental evidence substantiating this suggestion. Their results also indicated that lecithin is the most logical source of the trimethylamine. However, Rogers (2) objected to this theory because he was able to detect the fishy flavor in the distillate from butter that had been acidified with dilute sulphuric acid. He concluded that this eliminated basic substances from consideration as the fishy compound. This objection has thus far remained unanswered.

Thus the conditions that favor fishiness are quite well established, but uncertainty exists as to the agencies that produce it, and as to the identity of the fishy compound and its mother substance. Therefore further experimental work was undertaken. The plan that was followed in this work was:

1. Determine the factors that favor the development of fishiness.
2. Study the conditions under which lecithin will yield trimethylamine.

3. Determine whether the decomposition of the lecithin is chemical or biological.
4. Determine whether lecithin-added butter will become fishy more readily than normal butter.
5. Analyze normal and fishy butter for trimethylamine.

CONDITIONS THAT FAVOR THE DEVELOPMENT OF FISHINESS.

The conditions that favor the development of fishiness in butter were studied experimentally by making butter from Pasteurized and un-Pasteurized cream, ripened to various degrees of acidity. From this butter, samples were prepared to represent unsalted, 1.5 per cent and 3 per cent salted butter, and 3 per cent salted butter plus iron oxide and iron lactate, and overworked butter. The samples were stored at 35° F., and at -10° F., and scored from time to time for fishiness. At the end of four months, fishiness had developed in some of the samples stored at 35° F., and in six months at -10° F.

Fishiness occurred only in the salted samples, and there only in the overworked samples and in the samples containing ferric oxide or ferrous lactate.

Fishiness occurred mainly in the high acid samples. Unripened or neutralized samples did not become fishy except in two cases, and these were samples containing ferrous lactate.

Fishiness occurred mainly in the un-Pasteurized samples. Two Pasteurized samples to which ferrous lactate had been added became fishy.

These results are entirely in accord with the conclusions that may be drawn from the literature. The various investigators are practically unanimous in the conclusion that high acid favors fishiness. Furthermore, Rogers and Gray (8) have demonstrated by adding acids artificially that it is the acid itself that caused the development of fishiness.

There is some difference of opinion on the effect of salt on fishiness. O'Callaghan (9) states that many Australian consignments of unsalted butter have turned out fishy in London; while Rogers (11) states that he has never met fishiness in unsalted butter. Fishiness can undoubtedly occur in unsalted butter, but it is evident from the work of Thomson (10), Rogers (11), Washburn and Dahlberg (12), Supplee (6), and Cusick (7), that this defect occurs mainly in salted butter.

Overworking the butter favors fishiness, as shown by the work of Rogers (2), Weigmann (13), Reakes, Cuddie and Reid (3), Hunziker (14), McKay (15), and Davis (16).

The presence of small amounts of iron and copper salts favors fishiness, as shown by the work of Rogers et al. (17), Rogers (11), Washburn (18), and Hunziker (14).

The review of the literature shows the Pasteurization tends to prevent fishiness. However, this defect is found to some extent even in Pasteurized butter, so that we must conclude that Pasteurization is not an absolute preventive.

Thus, from our experiments, and from a review of the literature, we may briefly state that high acid, high salt, overworking the butter, and the presence of iron and copper salts favor the development

of fishiness; and that Pasteurization tends to check, but not absolutely to prevent fishiness.

THE CHEMICAL DECOMPOSITION OF LECITHIN.

As stated above, it has been suggested that trimethylamine is the fishy compound and lecithin its mother substance. If this is the case, then lecithin must yield trimethylamine under the conditions which are known to produce fishy butter. In order to determine this experimentally, lecithin decomposition experiments were undertaken.

The lecithin used was prepared from egg yolks according to the method described by Long (22).

The trimethylamine was determined by the method used by Supplee (6). The volatile bases were absorbed in standard acid by aspirating them from the sample made alkaline by potassium carbonate. They were then determined by titrating the excess acid with standard alkali. The ammonia was then converted into hexamethylene-tetramine by the addition of neutral formaldehyde. The acid thus liberated from the ammonia gave a measure of the ammonia present, and the trimethylamine was then obtained by difference between the ammonia and the total volatile bases. By this method 99.23 per cent of the ammonia and 97.57 per cent of the trimethylamine were accounted for in four trial determinations on mixtures of ammonia and trimethylamine in known amounts.

Lecithin emulsions were made and subjected to various conditions. It was assumed that butter becoming fishy had 0.1 per cent lecithin, 16 per cent moisture, and 2 to 4 per cent salt. Assuming that all the salt, acid, and lecithin in the butter were dissolved in the brine of the butter, emulsions were prepared to imitate the concentrations of the above assumed butter brine. Small amounts of ether were added to each tube to inhibit the development of bacteria. The tubes were then tightly sealed with paraffin wax and incubated at 35° C. for six weeks. The trimethylamine was then determined, and expressed as per cent of the total theoretically possible from the amount of lecithin in the sample. The exact combinations studied and the results obtained are given in Table 1.

TABLE 1.—*Chemical decomposition of lecithin into trimethylamine (first experiment).*

Treatment of sample. ¹	0.1 per cent lecithin plus—		
	Nothing.	0.1 per cent ferrous lactate.	1 cubic centimeter hydrogen peroxide.
No salt, no acid	4.99	4.74	4.31
2 per cent salt, no acid	5.17	.86	5.26
4 per cent salt, no acid	5.17	.86	5.17
No salt, 0.25 per cent lactic acid	5.60	5.69	8.62
No salt, 0.50 per cent lactic acid	5.69	5.69	9.48
2 per cent salt, 0.25 per cent lactic acid	6.20	5.86	11.20
4 per cent salt, 0.25 per cent lactic acid	6.20	5.77	11.20
2 per cent salt, 0.50 per cent lactic acid	6.89	7.32	22.40
4 per cent salt, 0.50 per cent lactic acid	7.07	7.75	22.83

¹ Concentration of salt, acid, and lecithin expressed as per cent of butter containing 16 per cent water; i. e., the concentration of the solutions was actually six and one-fourth times as high as stated.

The experiments reported in Table 1 were repeated in a similar manner except that mercuric chloride was used as a preservative instead of ether, and two additional series were added. These samples were incubated three weeks at 28° C. The results are given in Table 2.

TABLE 2.—*Chemical decomposition of lecithin into trimethylamine (second experiment).*

Treatment of sample. ¹	0.1 per cent lecithin plus—				
	Nothing.	0.1 per cent ferrous lactate.	1 cubic centimeter hydrogen peroxide to 14 cubic centimeters.	Air replaced by oxygen.	0.1 per cent ferrous lactate and oxygen.
No salt, no acid.....	1.89	1.46	2.49	2.16	2.50
2 per cent salt, no acid.....	2.85	1.66	5.77	2.85	4.65
4 per cent salt, no acid.....	2.85	2.50	5.77	2.85	4.99
No salt, 0.25 per cent lactic acid.....	4.22	3.32	8.79	6.55	6.60
No salt, 0.50 per cent lactic acid.....	4.48	4.32	10.34	10.52	7.93
2 per cent salt, 0.25 per cent lactic acid.....	5.60	4.98	11.29	14.65	8.43
4 per cent salt, 0.25 per cent lactic acid.....	5.60	5.77	11.20	14.82	8.13
2 per cent salt, 0.50 per cent lactic acid.....	5.77	7.41	13.78	17.23	8.57
4 per cent salt, 0.50 per cent lactic acid.....	6.29	7.41	14.04	17.75	9.13

¹ See footnote on Table 1.

The results of these experiments, as shown in Tables 1 and 2, demonstrate that lecithin will undergo decomposition and yield trimethylamine under conditions that exclude bacterial action. This decomposition took place to the greatest extent under conditions that combine salt, high acid, and oxidation, the very same factors that favor the development of fishiness in butter. Thus these results lend support to the theory that the fishy flavor is due to chemical decomposition of lecithin into trimethylamine.

THE BACTERIAL DECOMPOSITION OF LECITHIN.

In studying the decomposition of lecithin by bacteria, two organisms were used, *Bact. ichthyosmius* and an organism isolated from fishy cream. Both organisms were obtained through the courtesy of Professor Hammer.

The various culture media containing lecithin were sterilized 30 minutes at 15 pounds pressure. By experiment it was found that this sterilization liberated traces of trimethylamine from the lecithin, but the amount was negligible and ignored in the subsequent work.

An attempt was made to grow *Bact. ichthyosmius* and the fishy cream organism in 0.1 per cent lecithin emulsions, but no growth could be obtained. When these two organisms were grown in skimmed milk to which 0.1 per cent lecithin had been added, an abundant growth was obtained. These organisms first coagulated the milk and then digested it, leaving a brownish liquid of a repugnant odor. On analysis both organisms indicated a production of trimethylamine about eight times as great as could possibly be produced from the

lecithin present. Supplee (6) had also reported large amounts of trimethylamine produced from skimmed milk by *Bact. ichthyosmius*.

It was at first thought that this additional trimethylamine was derived from the milk proteins. However, the proteins give rise only to primary and secondary amines unless synthetic action is involved. This suggested the idea that the method of analysis used did not eliminate the primary and secondary amines. By experiment it was found that this was actually the case.

This difficulty was overcome by treating the aspirated volatile bases with nitrous acid to destroy the primary and secondary amines. After this treatment, the remaining ammonia and the trimethylamine were again aspirated and determined as in the former method. By means of this method in trial determinations it was possible to account for 97.57 per cent of the tertiary amine known to be present in mixtures of ammonia and amines.

This method of analysis was then applied to cultures of the fishy cream organism and *Bact. ichthyosmius* in casein solutions, in skimmed milk, and in skimmed milk containing 0.1 per cent lecithin. In the casein solutions and in the skimmed milk, only negligible traces of trimethylamine were found by this method. In the skimmed milk containing 0.1 per cent added lecithin, both organisms produced a little over 9 per cent of the trimethylamine theoretically possible from the lecithin added.

From these results it seems that even where bacteria are involved in the production of fishiness, the source of the trimethylamine is lecithin.

Attempts were made to grow these two organisms in emulsions containing 10 per cent salt and 0.30 per cent lactic acid, imitating butter brine. However, under these conditions no growth could be obtained. This would indicate that while these organisms can produce trimethylamine from lecithin under favorable conditions, they can not be regarded as important agencies in the production of trimethylamine in storage butter.

THE PRODUCTION OF TRIMETHYLAMINE FROM UNHYDROLYZED AND HYDROLYZED LECITHIN.

The fact that the development of fishiness in butter and the chemical decomposition of lecithin into trimethylamine are favored in acid solutions, suggests that these changes require, as their first step, the hydrolysis of the lecithin. It was therefore decided to study the bacterial and chemical production of trimethylamine from hydrolyzed and unhydrolyzed lecithin.

A 1.85 per cent lecithin emulsion in N lactic acid was hydrolyzed by heating it under a reflux condenser for 13 hours. The clear yellow liquid which resulted was separated from the oily layer by filtering and washing. It was then made up to a definite volume and analyzed for choline by forming the double salt of choline with mercuric chlorid, according to the method of Tosaka Kinoshita (19). This solution yielded 88.9 per cent of the choline theoretically possible.

TABLE 3.—Percentage decomposition of unhydrolyzed and hydrolyzed lecithin into trimethylamine.

Sam- ple No.	Treatment of sample 0.25 gram lecithin in 186 cubic centimeters.						Unhydrolyzed lecithin.		Hydrolyzed lecithin.	
	Salt.	Acid.	Heated.	Hydro- gen per- oxyde.	Ferrous lactate.	Copper sul- phate.	Chem- ical.	Bac- terial.	Chem- ical.	Bac- terial.
	Per ct.	Per ct.		Cc.	Per ct.	Per ct.				
1							1.46	{ ¹ 4.23 ² 4.39 }	3.04	{ ¹ 12.27 ² 12.91 }
2				2		0.1	3.19		4.84	
3				2	0.1		2.34		4.36	
4		0.5					1.66		3.78	
5		.5		2		.1	6.77		15.66	
6		.5		2	.1		6.64		14.95	
7		.5	140° F., 30 minutes.				1.98	{ ¹ 1.95 ² 1.98 }	3.16	{ ¹ 3.13 ² 3.10 }
8		.5	180° F., 1 minute.				1.66	{ ¹ 1.66 ² 1.63 }	3.07	{ ¹ 3.11 ² 3.09 }
9	15						1.50		3.12	
10	15			2		.1	3.06		5.04	
11	15			2	.1		3.00		4.58	
12	15	.5					4.20		3.86	
13	15	.5		2		.1	12.91		15.14	
14	15	.5		2	.1		12.13		15.15	
15	15	.5	140° F., 30 minutes.	2		.1	13.66		16.57	
16	15	.5	180° F., 1 minute.	2		.1	12.85		15.98	

¹ *Bact. ichthyosmius*. ² Fishy cream organism.

It is evident from Table 3 that the yield of trimethylamine is about twice as high in the hydrolyzed lecithin series as in the unhydrolyzed lecithin series.

Salt caused an average increase of 2.45 per cent in the trimethylamine yield in the unhydrolyzed series and only 0.34 per cent in the hydrolyzed series. (Compare samples 9 and 1, 12 and 4, 10 and 2, 11 and 3, 13 and 5, 14 and 6). This suggests the hypothesis that the stimulating effect of the salt in the production of trimethylamine is due to its solvent action on the lecithin.

The presence of acid caused a big increase in the trimethylamine production (compare samples 4 and 1, 12 and 9, 5 and 2, 6 and 3, 13 and 10, 14 and 11), both in the unhydrolyzed and hydrolyzed lecithin series. In the unhydrolyzed lecithin series the acid caused an increase of 4.96 per cent of trimethylamine, while in the hydrolyzed series, 7.43 per cent.

It will be noted in sample 1 that even in the bacterial decompositions the largest yields of trimethylamine were obtained in the hydrolyzed lecithin series, indicating that here, too, choline is first formed by hydrolysis. Pasteurized samples 7 and 8 were not acted upon when inoculated with the organisms, undoubtedly due to the acidity of the medium.

FISHINESS IN LECITHIN-ADDED BUTTER.

If lecithin is the source of the trimethylamine which causes the fishiness in butter, then butter made from cream to which lecithin has been added should become fishy more readily, provided there are no other limiting factors.

From three lots of cream containing, first, no added lecithin; second, 0.135 per cent added lecithin; and, third, 0.27 per cent added lecithin, butter samples were prepared representing combinations of the following factors: 0.17 per cent acid, 0.50 per cent acid, no salt, 3 per cent salt, normally worked, overworked, and hydrogen peroxide added. After 102 days' storage of these samples at 35° F., fishiness had not developed in any of the butter to which lecithin had not been added, but it had developed in the added-lecithin butter samples and there only in the high-acid, high-salt sample.

Thus these results lend support to the theory that lecithin is the mother substance of the fishy flavor, and in addition they again emphasize that high-acid and high-salt favor fishiness.

TRIMETHYLAMINE AS THE CAUSE OF FISHINESS.

If trimethylamine is to be regarded as the immediate cause of fishiness, and lecithin its mother substance, then butter must contain lecithin in amounts sufficient to produce enough trimethylamine to impart fishiness. That butter contains lecithin is well established by a large number of investigators. The amount found ranges from 0.01 to 0.17 per cent. Assuming lecithin of the distearyl type, and that all of its nitrogen can be changed to trimethylamine, 0.17 per cent lecithin will produce 125 parts of trimethylamine per million parts of butter, or the average (of the two extremes) lecithin content of 0.09 per cent would yield 66 parts per million.

Supplee, working 80 parts of trimethylamine salts into a million parts of butter, found a distinct fishy odor and flavor. In our experiments, 100 parts of trimethylamine lactate were worked into a million parts of normal fresh butter, with the result that the butter judges and laymen who tasted the butter pronounced it distinctly fishy.

Rogers (2) objects to the trimethylamine theory for two reasons: first, he worked large amounts of trimethylamine into butter and failed to obtain the characteristic fishy flavor; second, he was able to obtain the fishy odor in the distillate from acidified butter.

Relative to the first objection, it is likely that the fishy flavor was not obtained because excessive amounts of trimethylamine were incorporated, for in large amounts trimethylamine smells like ammonia and not at all characteristically fishy.

Relative to the second objection, we may state that it is based on the erroneous assumption that volatile bases can not be distilled from acid solutions in detectable amounts. A five-tenths per cent solution of trimethylamine sulphate made distinctly acid to litmus and alizarin gave off a distillate that had a distinct fishy flavor and odor.

This principle was even more conclusively demonstrated by distilling a 2 per cent solution of ammonium sulphate acidified to varying degrees. Heating 1 liter of solution in a 2-liter flask, and taking the necessary precautions, the first 50 cubic centimeters of distillate obtained from a solution of the reaction pH 6.2 contained 95.7 parts of ammonia per million. With increasing acidity the amount of ammonia in the distillate decreased progressively, but even at pH 2.4 there were obtained 13.7 parts of ammonia per million. Thus the main objections to the trimethylamine theory are answered.

The samples of butter analyzed for trimethylamine gave the results shown in Table 4.

TABLE 4.—*Trimethylamine content of normal and fishy butter.*

Sam- ple No.	Description of sample.	Trimethyla- mine con- tent in parts per million parts of butter.
1	Normal fresh butter.....	None.
2	.....do.....	None.
3	Fishy butter, commercial sample No. 1.....	32.65
4	Fishy butter, commercial sample No. 2.....	32.45
		22.37
5	Fishy butter, sample of experimental butter furnished by Professor Hunziker.....	22.37
		35.97
6	Fishy butter, experimental butter containing 0.4 per cent acid and 0.1 per cent ferrous lactate.....	35.92
		23.72
7	Fishy butter, experimental butter containing 0.6 per cent acid and 0.1 per cent ferrous lactate.....	23.80
		25.20
		25.10

CONCLUSION.

We may therefore conclude that trimethylamine is the immediate cause of fishiness in butter, and that it is produced mainly, if not entirely, by the chemical decomposition of lecithin. The conditions which favor this decomposition are also the conditions that are known to favor the development of fishiness, viz, high acid, high salt, overworking, and the presence of iron or copper salts.

THE RÔLE OF THE VARIOUS FACTORS CONCERNED IN THE DEVELOPMENT OF FISHINESS.

From the experimental evidence presented in this paper and from the literature, we may advance hypotheses to explain the rôle of the various factors concerned in the development of fishiness.

I. Why is fishiness more common in salted than in unsalted butter?

1. Salt intensifies flavors of all kinds.
2. Salt brine is a good solvent for lecithin. In salted butter the lecithin is in more complete solution, hence its decomposition is more rapid.
3. Salting necessitates the additional working of butter, and working favors fishiness.
4. The salt lowers the freezing point of the brine.

II. Why does high acid favor fishiness?

1. Acids favor the hydrolysis of lecithin. Hammersten and Heddin (20) state that lecithin is slowly decomposed by dilute acids.
2. Acids accelerate oxidation in butter. Dyer (4) and Rogers (2) have found that the rate of oxidation in butter is proportional to the acidity.
3. Acids in the cream cause the cream to dissolve iron and copper, which favor fishiness.

III. Why does overworking favor fishiness?

1. Overworking may increase the air content of butter. The production of trimethylamine from lecithin is apparently oxidative, and an increase in the available oxygen may accelerate its production.
2. Overworking distributes the incorporated air more thoroughly, so that, as Rogers (2) has shown, oxidation will proceed more rapidly.
3. Overworking distributes the brine more thoroughly and makes the solution of the lecithin more complete.

IV. Why do iron and copper salts favor the development of fishiness?

1. Iron and copper salts act as catalysts in oxidation reactions. They accelerate the oxidation of the lecithin into trimethylamine.

V. Why does Pasteurization tend to eliminate fishiness? If we eliminate biological agencies as the cause of fishiness as we have done in our conclusion, how can we account for the fact that Pasteurization tends to prevent fishiness?

1. Pasteurization may lower the solubility of the lecithin. It is well known that lecithin readily absorbs oxygen and becomes less soluble. Such an oxidation should proceed to a greater extent in Pasteurizing at 145° F. for 30 minutes than at 180° F. for 1 minute. This is in harmony with the observation that the former process is most effective in preventing fishiness.
2. Pasteurization reduces the lecithin content of the resulting butter, undoubtedly through the hydrolysis of the lecithin and its loss in the buttermilk. Supplee (6) and Dornic and Daire (21) have actually demonstrated that Pasteurization reduces the lecithin content of butter. Here again it is to be expected that Pasteurization at 145° F. for 30 minutes will cause greater hydrolysis than 180° F. for 1 minute.

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Chairman BORMAN. Gentlemen, the paper is now open for discussion. Have you anything to add to what Professor Sommer just read?

Mr. G. L. A. RUEHLE (Michigan Agricultural College). I would like to ask what concentration was used in controlling the bacteria?

Doctor SOMMER. A concentration of 1 to 1,000.

Mr. RUEHLE. That was by actual bacteriological work?

Professor SOMMER. An attempt was made to obtain growth on lower lines and absolutely no growth was obtained.

Mr. WOOD (Pennsylvania). I would like to ask why butter turns white, especially this fishy butter.

Professor SOMMER. We have not studied that phase of the problem, but, offhand, I would say that undoubtedly the destruction of the color is influenced by the same factor that influences the development of fishiness. We have shown that oxidation is one of the factors necessary for the development of fishiness.

Mr. HUNZIKER. I desire to ask Professor Sommer if any of his samples of fishy butter had become bleached.

Professor SOMMER. In fact all of them had bleached. In that respect they were not necessarily different from other samples. Our experimental butter samples were stored in glass jars. They were churned in earthenware churns, and all the way through an attempt was made to avoid contact with metallic surface. Since they were stored in glass jars, where the light could reach the sample, they had a bleached appearance. In that respect, the fishy samples were not different from the other samples.

Mr. HUNZIKER. It would appear, then, that the bleaching of the samples of Professor Sommer's investigation was due to exposure to light, because the samples were kept in glass jars, rather than to any connection with the agencies that produced fishiness.

Our experience with the production of tallowy flavor in butter has been that the bleaching of the color goes usually hand in hand with the development of tallowy flavor rather than with fishy flavor. We have learned to look upon tallowy and fishy flavors as being first cousins. Both result from very much the same combination of factors with the exception of the factor of acid reaction. High acid tends to produce fishiness, while the tallowiness and bleaching are prone to result from the absence of acidity or the presence of alkalinity, other factors being the same. Unless the butter is excessively exposed to light, which will invariably bleach it, bleaching appears to be due to conditions that produce an alkaline condition, such as improper neutralization or overneutralization. This bleaching

is intensified and accelerated in the presence of metals or metallic salts.

Chairman BORMAN. The time for the discussion of this paper has expired.

We will now take up Mr. Hammer's paper. Professor Mortensen, the head of Mr. Hammer's department, is here, and we are wondering if he will read Mr. Hammer's paper for us.

Professor MORTENSEN. I would rather have the secretary read it, if he will.

(Secretary Clevenger read Mr. Hammer's paper.)

THE ACTION OF THE ORGANISMS PRESENT IN THE STARTERS USED IN BUTTER MAKING.

BERNARD W. HAMMER, professor of dairy bacteriology, Iowa State College, and chief in dairy bacteriology, Iowa Agricultural Experiment Station, Ames, Iowa.

The introduction of cultures of selected organisms for the development of flavor and aroma, together with the use of cream Pasteurization, has made it possible to put the manufacture of butter on a more certain and scientific basis than it was formerly. The cultures used were apparently at one time assumed to be pure cultures of lactic-acid organisms, but data published in the United States by the Iowa Agricultural Experiment Station (1), and in Europe by Storch (2), and by Boekhout and Ott de Vries (3) have proven this assumption to be incorrect, and have indicated that at least two types of organisms are present. Further studies have shown that these two types are very different in their biochemical features, although their morphological and cultural characters are quite alike. The Iowa Agricultural Experiment Station has, for a number of years, been interested in the action of the organisms present in the starters used in butter making, and the present paper is in part a summary of the results that have been obtained in a study of them. The work has dealt to a large extent with the volatile acid production because this is comparatively easy to determine, and the volatile acids are believed to be important among the products necessary for the proper flavor and aroma development. It must be recognized, however, that the production of considerable volatile acid is no guaranty that a starter will be satisfactory, since there are many types of defects in starters.

DETERMINATION OF THE VOLATILE ACID PRODUCTION.

The method used for determining the volatile acidity produced in milk consists of distilling a 250-gram portion with steam after the addition of 15 cubic centimeters of approximately N/1 H_2SO_4 until 1,000 cubic centimeters of distillate have been obtained, and then titrating this distillate with N/10 alkali, using phenolphthalein as an indicator. The results are expressed as the cubic centimeters of N/10 alkali required. This method does not by any means get all the volatile acid out of the milk, but gives results that are comparative and of value in investigating many starter problems.

Starters ripened to a fairly high total acidity usually show a volatile acid production of from 30 to 38 (1), while starters distilled at about the time of coagulation give somewhat lower values. The volatile acid production of starters is quite uniform even when they come from a wide variety of sources.

EVIDENCE THAT STARTERS ARE NOT PURE CULTURES.

Evidence that the starters used in butter making are not pure cultures of *S. lactis* has been secured along several different lines; it may be summarized as follows:

1. Cultures of *S. lactis* produce only small amounts of volatile acid while starters produce comparatively large amounts (1).
2. By preparing a series of dilutions of a starter, cultures can be secured which coagulate milk rapidly but which yield only a low volatile acidity (1) like that of *S. lactis*. This indicates that an organism responsible for the high volatile acidity in the starter has been diluted out.
3. Organisms other than *S. lactis* can be isolated from good starters (1) (2) (3).
4. Satisfactory starters can not be prepared from pure cultures of *S. lactis*, but can be prepared from mixtures of *S. lactis* and another organism isolated from starter (4).
5. Only *d* lactic acid is produced by cultures of *S. lactis* isolated from starters while the starters themselves yield some *i* lactic acid (5).
6. The ratio between the volatile and total acidities in a starter is quite different from that in a pure culture of *S. lactis* (6). Moreover, in the case of a starter, this ratio changes as the acidity goes up but remains quite constant with a culture of *S. lactis*.
7. *S. lactis* does not cause a decrease in the citric acid in milk in which it is grown while a starter does cause such a decrease (7).
8. The volatile acids distilled from well-ripened starters have barium¹ and Duclaux values different from those distilled from pure cultures of *S. lactis* (7).

TYPES OF ORGANISMS IN A STARTER.

The organisms present in the starters used in butter making may be conveniently classed as follows: (1) *S. lactis*, which is the rapid acid-producing organisms; and (2) the associated organisms, which are important from the standpoint of flavor and aroma development. These have been divided into two types, *S. citrovorus* and *S. paracitrovorus*, on the basis of differences in the total and volatile acid production in milk (4). It should be recognized that there is no sharp distinction between these but that the one type grades into the other since the total acid production of *S. paracitrovorus* is quite variable.

S. lactis is largely responsible for the development of acid in a starter. The acid produced is mainly nonvolatile, being lactic, but a small amount of volatile acid is also formed. The values for the volatile acid production fall in general between 4 and 9, with an

¹ The barium value equals the per cent barium in the barium salt. The theoretical value for barium acetate is 53.78 per cent and for barium propionate 48.46 per cent.

occasional result outside these limits. The barium values on the volatile acids formed vary usually from 50 to 52 per cent (7), and these, together with the Duclaux values, indicate acetic acid with propionic acid in considerable amounts. With *S. lactis* there is apparently no action on the citric acid present in milk or cream, and the evidence thus far secured suggests that *S. lactis* attacks mainly the lactose.

S. lactis is usually present in a starter in larger numbers than the associated organisms. It frequently makes up over 90 per cent of the flora and only occasionally falls under 75 per cent (4). Starters have been observed, however, in which, for no evident reason, *S. lactis* was present in much smaller numbers than the associated organisms.

ACTION OF THE ASSOCIATED ORGANISMS.

The striking character of the associated organisms is their production of volatile acid in considerable amounts. The total acid production in a starter is probably influenced very little by these organisms because they increase the total acidity in milk comparatively slowly.

S. citrovorus usually gives volatile acidities from 15 to 22, although, in some instances, values outside these limits may be secured (1) (4). It increases the total acidity of milk only very slightly, and accordingly does not turn litmus milk pink. The volatile acid production is greatly increased by the addition of sterile citric acid to the milk in which the organism is grown, and volatile acid values up to 50 or 60 are sometimes obtained by adding three-tenths to four-tenths per cent citric acid to the milk (4). Added lactic acid (4) also increases the volatile acid production, but not to such a pronounced degree as citric acid, since the volatile acidity with added lactic acid is not increased over the values obtained with a starter. *S. citrovorus* (7) decreases the citric acid content of milk in which it grows.

S. paracitrovorus usually gives volatile acidities higher than *S. citrovorus*—in general from 20 to 31—but there is a great deal of variation in the volatile acid production. With 124 cultures of *S. paracitrovorus* isolated from milk, cream and butter, the volatile acidities varied from 12.5 to 40, and averaged 28.6 (7). *S. paracitrovorus* reddens litmus milk and sometimes produces sufficient acid to cause coagulation of the milk. The 124 cultures, whose volatile acid production was just mentioned, gave total acidities varying from 0.27 to 0.99 per cent and averaging 0.46 per cent, with the acidities of 57.3 per cent of the cultures ranging from 0.31 to 0.50 per cent. The amount of total acid produced in milk by a certain culture may vary considerably from one time to another, and a culture that coagulates on one transfer may not on the next. The addition of citric acid to the milk to be fermented increases the volatile acid production (4) (7). With the 124 cultures already referred to, four-tenths per cent citric acid added to the milk resulted in volatile acidities from 44.4 to 96.6, with an average of 73.9. Each of 47 of these cultures, taken with no attempt at selection, destroyed all of the citric acid present in milk in which it had grown (7), and this shows conclusively the action of the organisms on citric acid. The influence of adding lactic acid was tried with

a number of cultures isolated from starters, and while increases were obtained, these were usually so small as to be of little significance (4); this is to be expected since *S. paracitrovorus* seems to produce lactic acid itself, and this should be as effective as lactic acid from other sources. With *S. paracitrovorus* there apparently is no definite relation between the total and volatile acidities, although there seems to be a tendency for a slightly higher volatile acidity with the organisms producing the higher total acidities.

The barium values secured on the volatile acids produced by the associated organisms, were usually above 53 per cent (7), and these, in combination with the Duclaux values, indicate that acetic is the important volatile acid formed, although there is a small amount of propionic in addition.

The statement made with reference to the prominence of *S. lactis* in starters from the standpoint of numbers shows that the associated organisms as a rule make up only a small percentage of the total flora.

COMBINED ACTION OF THE ORGANISMS IN A STARTER.

Neither *S. lactis* nor the associated organisms in pure culture in milk yield a product at all comparable to a starter. *S. lactis* coagulates rapidly, but the curdled milk is lacking in flavor and aroma. *S. citrovorus* fails to curdle the milk and, like *S. lactis*, is lacking in flavor and aroma, due apparently to the fact that the volatile acids formed are largely fixed by the constituents of the milk. *S. paracitrovorus* curdles milk only very slowly, if at all, and while old cultures may show some aroma that is at least suggestive of the aroma of a starter, there is no close resemblance; here also the volatile acids are probably largely fixed by the constituents of the milk.

By combining *S. lactis* with either one or both of the associated organisms, cultures can frequently be prepared that make excellent starters after a few transfers. All the associated organisms do not seem to be equally valuable for the preparation of starters. A culture capable of giving a good starter seems to persist in this characteristic.

The combination of the two types of organisms seems to give results quite different from those from either one alone, from the flavor and aroma standpoint. The main function of the associated organisms seems to be to produce volatile acid which comes, to a large extent, from the citric acid normally present in milk, while *S. lactis* produces a very small amount of volatile acid together with a large amount of lactic acid. The lactic acid tends to free the volatile acids from combination with the milk constituents, which is very important, and in addition apparently may serve as a source of a small amount of the volatile acid. The acid production of *S. lactis* is also responsible for keeping down contaminating organisms, since, in general, these organisms, which are present mainly because of their resistance to Pasteurizing temperatures, do not grow well in any appreciable acidity. Because of the acid formed by *S. lactis*, it is much easier to carry a culture of it or of a starter in Pasteurized milk than a culture of one of the associated organisms.

Boekhout and Ott de Vries (3) considered, as a result of their work, that the associated organisms form substances in milk from which the lactic acid bacteria produce aroma. This idea apparently comes from the following facts: (1) Cultures of lactic acid bacteria a few days old, and accordingly coagulated, were heated at 100° C. for some time, and, after cooling, inoculated with the associated type without the development of aroma; (2) Old cultures of the associated organisms heated at 100° C. for 10 minutes, cooled and inoculated with lactic acid bacteria, gave an aroma after from 5 to 10 days. The conclusion of Boekhout and Ott de Vries should be questioned for the following reasons: (1) The old cultures of *S. lactis* probably limited the growth of the associated organisms because of the acid present; (2) The acid formed by the cultures of *S. lactis* grown in the old heated cultures of the associated organisms probably in part freed the volatile acids produced by the associated organisms so that an aroma became evident.

The effect of one type of organism on the growth of the other can not be ignored in a consideration of the action of the starter organisms growing in combination. From the fact that acid, in general, tends to restrain the growth of organisms, it might be assumed that *S. lactis* would have a restraining action on the associated organisms, and it has been found that the addition of considerable amounts of sterile lactic acid to milk, into which the associated organisms are inoculated, prevents the development of the usual volatile acidity (4). However, these organisms are very tolerant of acid, since, as will be shown, they are most active late in the ripening period of a starter: and moreover, they are frequently present in an active condition in a starter that has been allowed to stand until it no longer contains living *S. lactis*. The associated organisms also have a restraining action on *S. lactis*. This can be shown by inoculating (4) one of the associated organisms into milk a day previous to *S. lactis*, or by inoculating the two types at the same time and comparing the growth with the growth of *S. lactis* alone in milk from the same lot. The restraining action is evident from the time required for coagulation, from the time elapsing between beginning and complete coagulation, and from the acidity developed.

The relation between the total and volatile acidity (6) with different percentages of total acid in a starter shows the period in the ripening of a starter when the different organisms are of importance. The volatile acid production is low during the early part of the ripening, and the percentage of the total acid made up of volatile acid (as determined by the method used) usually is from 3 to 5 per cent. This is about the value obtained with *S. lactis* throughout the entire period of its development. By the time a starter reaches an acidity of from 0.65 to 0.80 per cent the volatile acidity shows a considerable increase, and then there follows a period of rather rapid increase. With the rapid increase in the volatile acidity, the percentage of the total acidity that is made up of volatile acid also increases, and eventually equals 10 to 15 per cent (as determined by the method used). The time in the ripening of a starter when the rapid increase in the volatile acidity occurs indicates that the associated organisms are most active late in the ripening period while *S. lactis* practically controls the fermentation during the early part.

The barium and Duclaux values (7) on the volatile acids produced by a starter at different stages in the ripening show certain variations. Early in the ripening period the barium values on the volatile acids formed are low and, taken with the Duclaux values, indicate that acetic acid and rather large amounts of propionic acid are present. When a starter has developed considerable total acidity, the volatile acids formed have a somewhat higher barium value, and these, in conjunction with the Duclaux values, indicate that the volatile acid is largely acetic but with a small amount of propionic. Since the associated organisms produce volatile acids made up of acetic with only small amounts of propionic acid while *S. lactis* produces volatile acids made up of acetic with considerable amounts of propionic acid, the results on starters suggest that *S. lactis* must be the principal organism developing early in the ripening period, while later the associated organisms become active. With a starter, there does not seem to be any very definite acidity at which the change from a low barium value to a high barium value occurs, but rather a range throughout which this may take place.

EFFECT OF ADDING CITRIC ACID TO THE MILK ON THE DEVELOPMENT OF A STARTER.

The results obtained on adding citric acid to milk in which starters are to be grown have not been encouraging (7). Frequently, in comparative tests, the addition of citric acid to milk increased the volatile acidity produced by a starter over that produced in milk alone, even when all the citric acid was not used up in the unmodified milk. Often, however, there was no such increase, and in some instances, where an increase was obtained, it was not very significant. In a few trials the increases secured were considerable.

The effect of adding citric acid on the flavor and aroma development by the associated organisms (7) is rather difficult to determine because of the influence of the citric acid itself on the flavor. In some trials it seemed as though there were more aroma after adding the citric acid, while in others there seemed to be little difference. The variations in these results are in agreement with the variations in the data obtained on the effect of citric acid on the volatile acid production.

The determinations of the volatile acid production, made in conjunction with tests for the presence or absence of citric acid in the fermented milk, have shown that the volatile acidity produced in a starter at the time the citric acid disappears varies from about 24 to 26. In a series of 20 experiments (7) on sterilized milk from various lots, the highest volatile acidity observed with citric acid still present in the milk was 23.8, while the lowest value obtained with the citric acid gone was 24; in a series of 40 trials on Pasteurized milk from different sources, the values representing the same conditions were, respectively, 25.7 and 23.8. These results also indicate that in a well-ripened starter, where the volatile acidity usually ranges from 30 to 38, there must be a source of volatile acid other than the citric acid; the data already given suggest that this is lactic acid.

PRODUCTION OF FLAVOR IN BUTTER WITH PURE CULTURES OF ASSOCIATED ORGANISMS.

Considerable flavor and aroma can be produced in butter by growing cultures of one of the associated organisms alone in cream that has been carefully Pasteurized (8). Experiments have also been carried out by adding a small amount of citric acid to the Pasteurized cream before inoculating the associated organisms, and some very excellent flavored butter has resulted. The addition of lactic acid did not seem to be as satisfactory as the addition of citric, from the standpoint of flavor and aroma production. The quality of the butter made from cream in which one of the associated organisms had grown was so much more satisfactory than that of butter made from cream of the same lot without the growth of the organisms that the importance of the organisms in the production of flavor and aroma in butter was very clearly evident.

The keeping quality of butter made with cultures of the associated organisms has been most excellent in many instances, but not in all (7). Since tubs of butter made with the usual starters are often satisfactory, and it is only occasional lots that show a rapid deterioration, it seems evident that the use of pure cultures of the associated organisms does not solve the problem of the keeping properties of butter. Some of the results secured suggest that the original quality of the raw material is one of the important factors in determining the keeping quality, and that Pasteurization, or the selection of certain types of cultures, or both, can not overcome this.

CONTROL OF THE TYPE OF STARTER.

The preparation of starters by mixing cultures of *S. lactis* with one or more associated organisms suggests the possibility of controlling the character of starters by a selection of the organisms to be used. Certain *S. lactis* cultures, such as those giving a burnt or caramel flavor (*S. lactis* var. *maltigenae*), must be avoided. By the proper selection of organisms, it has been possible to secure starters showing much less tendency to develop high acidities than the usual commercial cultures, and such starters have given, in many instances, very excellent results in the dairy plants (7), both in the manufacture of butter and in the preparation of artificial buttermilk. Attention must be given to the selection of the associated organisms used, since all these organisms are not equally satisfactory.

The keeping quality of butter made with low-acid starters (7) is often very excellent, but not always so, and the results obtained along this line again suggest that the quality of the raw material is too important a factor in determining the keeping quality to be overcome by the nature of the starter used. However, the low-acid starters have been very satisfactory in many instances in securing a high flavor and aroma in butter.

Attempts to develop a certain character, such as low total acid production in a starter, bring up the question as to whether the character will be retained after it is once secured. From the results obtained (7), it seems that, while a certain quality in a starter

may persist for a long time, the probability is that it will not persist indefinitely. This is rather to be expected, since it is unlikely that a certain relationship between two or more organisms can be continuously maintained when there are so many factors, such as the temperature, the time of holding, contamination, etc., that may influence this relationship.

SUMMARY.

During the last few years the Iowa Agricultural Experiment Station has been studying the action of the organisms present in the starters used in butter making. The results obtained show in a number of different ways that starters are not pure cultures of *S. lactis*, as was apparently at one time commonly supposed, but contain, in addition to *S. lactis*, at least one organism that differs greatly from it, especially in the biochemical features. Much of the work has been along the line of volatile acid production, since this is easily determined, and good starters show considerable and rather definite amounts of volatile acid.

S. lactis is largely responsible for the total acid development in a starter, but it produces very little volatile acid. The volatile acid that is produced is acetic with propionic in rather large amounts; the organism has no action on citric acid. *S. lactis* is generally present in a starter in much larger numbers than the other organisms.

The organisms other than *S. lactis* found in starters—the associated organisms—have been divided into two types. *S. citrovorus* increases the total acidity of milk very little, but forms considerable amounts of volatile acid, while *S. paracitrovorus* produces a definite but variable increase in the total acidity and, on the average, more volatile acidity than *S. citrovorus*, although there is considerable variation in the volatile acid production of different cultures. The volatile acid with both organisms comes largely from the citric acid normally present in milk.

By combining *S. lactis* with one of the associated organisms, very good starters can frequently be prepared although neither organism alone is satisfactory. The lactic acid produced by *S. lactis* tends to free the volatile acids from combination with the milk constituents; it may serve as a partial source of the volatile acid, and keeps down contaminating organisms, while the associated organisms produce volatile acid which is important from the standpoint of flavor and aroma development. The associated organisms also exert a restraining action on the acid development by *S. lactis*.

Variations in the relationship between the total and volatile acidities, and also in the barium and Duclaux values, at different periods in the ripening of a starter, show that the associated organisms develop for the most part late in the ripening period, while *S. lactis* controls the fermentation during the early stages.

The addition of citric acid to milk that is to be used for starter making has not uniformly increased the volatile acid production during the period when the citric acid normally present in milk in part remains, nor has it uniformly improved the flavor and aroma.

Butter, with a very satisfactory flavor and aroma, can be made from Pasteurized cream, inoculated with one of the associated organisms after the addition of a small amount of citric acid to the

cream; this shows the importance of the associated organisms in the flavor and aroma production. The keeping quality of butter so prepared is usually very good, but in some few instances considerable deterioration occurred.

The preparation of starters by mixing cultures of *S. lactis* with cultures of the associated organisms suggests the possibility of controlling the characters of a starter by the proper selection of the organisms used. It has been possible by this method to develop starters showing little tendency to the development of excessive acidities. Although such starters have usually given butter with very good keeping qualities, they have not uniformly done so. The keeping quality of butter is probably so related to the character of the raw material that the type of starter is not the controlling factor in determining it. In all probability a certain character that is developed in a starter will not persist indefinitely although it may persist for a long time.

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Chairman BORMAN. We are running behind our schedule, gentlemen. Consequently, we will dispense with discussion of this paper.

We will now have the paper "The formation of butter in churning," by Dr. Otto Rahn, who is not here, but a summary of whose paper will be given in English by our interpreter.

(The interpreter read a summary of Doctor Rahn's paper.)

Chairman BORMAN. Gentlemen, the secretary will now read the paper "Some factors relating to the production of cream for butter making in New Zealand," by W. Dempster and G. M. Valentine. This paper is a short one, not technical, and will be disposed of promptly.

(Secretary Clevenger read the paper.)

SOME FACTORS RELATING TO THE PRODUCTION OF CREAM FOR BUTTER MAKING IN NEW ZEALAND.

WILLIAM DEMPSTER and GEORGE M. VALENTINE, dairy instructors, Department of Agriculture, New Zealand.

Conditions relative to the production of cream for butter making in New Zealand have undergone considerable changes during recent years, the chief contributing factors being the introduction of the

milking machine and the adoption of home separation. As 90 per cent of the feed is natural pasture, the dairy farmer has found that the best return is obtained from herds not exceeding 70 cows. With larger herds, a greater proportion of the grass is soiled and wasted, while gateways and shed surroundings are more difficult to keep in order.

With the growth of the dairy industry and an increasing number of large herds, labor became one of the difficult problems, and the introduction of the milking machine made its appeal to the owners of the larger dairies. It was not till some years later, however, that the influence of the mechanical milker was felt in the industry. Following the introduction of the machine the necessity for a type of shed to give quick dispatch to the cows arose, and the double bail (stall) walk-through shed was evolved. In this shed, 70 cows can be milked in two hours with four double bails fitted with four sets of teat cups. The invention of the releaser, whereby the milk is conveyed under partial vacuum direct from the cow to the milk cans or separator tank, was the next step, and this is practically the only type of machine in use to-day, when 50 per cent of the milk produced is drawn by mechanical means.

The immediate effect of the adoption of mechanical milking was a drop in the quality of the cream received at the factories, due chiefly to the faulty erection of plants and ignorance of the best method of cleaning. To a great extent this was the result of failure to recognize the influence of a dirty air system on the milk, and the misleading statements of salesmen regarding the amount of care necessary to keep the machine clean. It is now recognized that black or galvanized iron piping is unsuitable for the air system, and regulations have been adopted requiring brass piping for both air and milk systems, such piping to be erected in short lengths to facilitate cleaning. Experience has shown that milk of the highest quality can be produced by the mechanical milker, and the cleaning of the machines is comparatively simple. The difficulty has been to convince users that they can be kept clean all the time, but the following procedure has been found satisfactory.

Immediately after milking is finished, and while the pump is still running, the teat cups are washed and cold water is drawn through the milk pipes, followed by warm water in which washing soda or other cleanser has been dissolved, and finally boiling water. Lest there should be any doubt about the temperature of the last water, it should be taken from a vessel in which it is actually boiling, and used in such quantity that the whole of the milk system is thoroughly scalded, and that there will be no risk of the alkaline solution previously used affecting the succeeding lot of milk drawn. The efficiency of this system of cleaning will depend upon the two first waters being sufficient in quantity to remove all milk and grease, and on the temperature of the last water, chiefly the latter. Boiling water and soda should be drawn through the air system, then all plugs removed, releaser and vacuum tank taken down, and teat cups and rubber milk tubes placed in a clean covered can. Before starting next milking, cold water should be drawn through the machine to prevent adhesion of the milk to the pipes. It is recommended that once weekly the whole machine be dismantled and thoroughly

washed. The rubber parts should be placed in a boiler in cold water to which 1 teaspoonful of caustic soda has been added for every 2 gallons of water, and brought to the boil. The rubbers are then rinsed thoroughly in cold water.

With the adoption of mechanical milking, home separation made rapid progress, and for a time the butter made under this system did not compare with that made from whole milk. To-day probably 80 per cent of the cream used for butter making is separated on the farms. In this class of dairy it has been found to be good practice to have the releaser and separator in one room, and the engine in another, these rooms being semidetached from the shed and from each other by air passages 2 feet wide and open at both ends. The admission of air to both milk and air systems is continuous during milking, hence the necessity to see that the shed and surroundings are kept clean and that the engine is not placed in the same room as the releaser. Separating is carried on simultaneously with the milking, the cream being run over the water cooler and immediately removed to a shelter where it is kept in water or in the coolest atmosphere available, until it is dispatched to the factory.

Apart from any defect which may be present in the milk, due to feed flavors, diseases of the udder, retention of the afterbirth, impure drinking-water supply, dirty milking machine, etc., possible sources of contamination of the cream at this stage are a dirty separating room, bad ventilation, dirty skim-milk containers, engine in separator room, odors from a dirty drain, neglect to wash the separator at night, mixing warm cream with that from a previous skimming, dirty utensils, etc.

Although no feeding is done in the shed, supplementary crops are fed in the open and occasionally give considerable trouble in connection with cream flavor. A luxuriant growth of ordinary pasture in which there is a large proportion of trefoils and clovers will have the same effect. These flavors can be dealt with more or less successfully by skimming cream containing 45 per cent of fat or over, and by thorough cooling and stirring with a metal plunger. Weed flavors such as garlic, pennyroyal, etc., have not been successfully treated so far. For the other defects in milk mentioned the obvious remedy is to remove the cause. An impure atmosphere caused by a badly ventilated, dirty separator room, in which the odor of stale milk and oil mixes with the smell of the oil engine or a dirty drain, is fatal to the production of good cream, and if the latter is cooled in such surroundings it will receive more harm than benefit. Mixing warm and cold cream will also produce a characteristic flavor which is very hard to deal with.

A fat content of 40 to 45 per cent has been found most satisfactory, and where the cream is produced under clean conditions and properly cooled no difficulty is experienced in delivering it to the factory in good order. As water is the only available cooling medium, this presents some difficulty in certain districts where open streams are the only source of supply.

About 25 per cent of this cream is delivered to the factory daily, and an acid content of 0.15 per cent is common. About 40 per cent is delivered triweekly, showing from 0.2 to 0.5 per cent of

acid; and the balance twice weekly, showing 0.6 to 0.7 per cent of acid. The collection is usually undertaken by the dairy companies, most of which are cooperative, and the cost is borne wholly or in part by them. After partial neutralization with bicarbonate of soda, the cream is passed through a flash Pasteurizer at a high temperature, and immediately cooled to churning temperature without the addition of a starter.

On arrival at the factory the cream is graded into three classes, superfine and first and second grades, and in many factories the grade is indicated by points. Superfine is paid for at the rate of $\frac{1}{2}$ to 1 penny per pound above first grade, while second grade receives $\frac{1}{2}$ to 2 pence below first. A deduction of $\frac{1}{2}$ pence is also made by some factories on all cream testing below 35 per cent. Good has also been done by companies agreeing not to accept cream from a dairyman whose cream has been graded second by a neighboring factory.

This system of grading, combined with instruction on the farms, has been found to work very satisfactorily, and factories the butter from which scored an average of 90 to 91 points have raised their quality to 94 points and over as a result. The instructor, by personal inspection on the factory receiving platform, notes the cream which is defective, and proceeds to the farm and if possible locates the cause. It may be that the cream is being kept in an unsuitable place; the separator may not be washed at night, or if washed may not be scalded; there may be unclean surroundings; or a dirty milking machine. Or it may be necessary to make an examination of each cow and a curd test of her milk. Should the dairyman be ignorant of the proper method of washing his machine, for example, it is the instructor's duty to give him a practical demonstration. If he claims that he has done everything possible and still can not produce good cream, the instructor takes charge of the dairy until such time as the factory grading shows the cream to be of satisfactory quality. Generally speaking, the instructor is welcomed by the dairyman, and only in exceptional cases has he to exercise the powers conferred on him by the company employing him or by the Department of Agriculture, to close the premises until such improvements are carried out as he may consider necessary.

Many factories working on these lines are able to produce butter quite equal to that made under the whole-milk system; but where, owing to competition for supplies, cream is accepted and paid for without regard to quality, the butter made from it is inferior. Under proper control, the home separator has proved of great value in New Zealand, especially in opening up new districts, and without it the industry could not have reached its present volume. The milking machine also, through minimizing the dependence on labor, has played an important part in the same direction, more especially during the war years, during which, in spite of the large number of men engaged in war work, the dairy products of the Dominion were not only maintained but increased.

Chairman BORMAN. That is a very interesting paper, but since neither of the authors is present the discussion will be dispensed with.

We have a paper by Prof. J. R. Keithley, of the department of dairy husbandry, University of Minnesota, entitled, "The commercial significance of the variable constituents of creamery butter." Running over this paper, I conclude that it is a very valuable paper. It is fortunate that this, with other papers, will be printed and available to all those who are interested. I will undertake to very briefly read excerpts for Professor Keithley's paper. He has in it a number of tables which would be presented with slides. I will, of course, not attempt to read those.

(Chairman Borman proceeded to read excerpts from Mr. Keithley's paper.)

Chairman BORMAN. In line with the rules which govern the chairman under circumstances of this kind, I refer to the fact that we still have undisposed of a paper on "The importance of the equilibria in the system milk fat in making of butter." by Doctor van Dam. This paper, unless otherwise requested, will be read by title.

If there are no further questions or points to be raised on the papers presented, the meeting will stand adjourned.

(Adjournment.)

(Papers read by title):

THE COMMERCIAL SIGNIFICANCE OF THE VARIABLE CONSTITUENTS OF CREAMERY BUTTER.

JOSEPH RAYBURN KEITHLEY, professor of dairy husbandry, University of Minnesota, University Farm, St. Paul, Minn.

The quality and composition of creamery butter vary widely. Such variation is of tremendous commercial significance. The quality of butter varies widely due to minute quantities of substances, which, to a large extent, still baffle both the chemist and bacteriologist, as well as the manufacturing specialist and business man. The variable quantities of these minute substances determine the grade of butter and the price received for it. The composition of butter varies even more widely than the quality, and is of almost equal commercial significance, because it is more easily under the control of the manufacturer and determines the quantity of butter obtainable from a definite amount of butterfat.

In this paper data will be submitted showing the commercial significance of: (1) The variable constituents which affect the quality of butter; and (2) the variable constituents which affect the composition of butter.

COMMERCIAL SIGNIFICANCE OF QUALITY IN BUTTER.

There is produced in the United States approximately 1,054,000,000 pounds of creamery butter. This butter is composed of water, butterfat, salt, curd, and, in addition, various volatile substances which are responsible for its flavor, yet which are present in very small amounts. Many of these complex substances are still undetermined either qualitatively or quantitatively. Their presence is

recognized by the senses of taste and smell. The quantity and nature of these substances greatly affect the commercial value of the product.

Butter is divided into market grades or classes on the basis of its score, and this score is in turn dependent upon these volatile substances. It is not the aim or intent of this paper to discuss these substances, important as they are, but rather briefly to indicate their commercial significance. The score card for butter is as follows:

Flavor	45
Body	25
Color	15
Salt	10
Package	5

By use of this score card butter is scored on the New York market, and daily quotations are published for butters scoring between 93 and 86. These prices fluctuate from day to day and from season to season. The quantity of the different grades of butter on the market each day varies. This is no doubt also true on all principal butter markets, so that it is difficult, if not practically impossible, to ascertain the percentage of each grade of butter which reaches the market. Estimates (1) have, however, been made from time to time and may be used as a guide to probable losses due to poor quality butter. The following tabulated data give an estimate of the percentage of the different grades on the Chicago market, and the average price of each grade of butter on the New York market, for the years 1920, 1921, and 1922:

TABLE 1.—*Showing percentage of each score, the score, and average prices of creamery butter.*

Percent- age of all butter.	Grade score.	Year.		
		1920	1921	1922
		<i>Cents per lb.</i>	<i>Cents per lb.</i>	<i>Cents per lb.</i>
2	93	62.39	44.29	41.29
3	92	61.21	43.33	40.52
10	91	59.98	42.27	39.40
20	90	58.16	40.55	37.75
25	89	55.77	39.09	36.29
25	88	54.49	37.54	35.30
10	87	52.46	36.08	34.00
5	86	50.79	34.50	32.40

If it had been possible to make all butter so as to score 93 and it had brought 93 score prices, Minnesota alone would have received:

- In 1920, \$9,045,332 more for 143,000,000 pounds of butter.
- In 1921, \$8,870,560 more for 170,000,000 pounds of butter.
- In 1922, \$8,289,560 more for 170,000,000 pounds of butter.

In other words, is an annual loss of over \$8,000,000 resulting on each 170,000,000 pounds of butter per year in the United States due to poor quality? These figures and estimates indicate the tremendous commercial significance of some of the variable constituents

of creamery butter. Considerable study and effort could profitably be undertaken to ascertain what these variable substances are and how their presence and quantity can be controlled. The substances which develop during storage periods also have an important commercial significance. Work along this line requires the services of the chemist and bacteriologist.

COMMERCIAL SIGNIFICANCE OF COMPOSITION OF BUTTER.

The study reported in this paper is primarily concerned with the variations occurring in the water, fat, salt, and curd of butter, and the commercial significance of this variation. The water and fat content of butter is rather definitely established by competitive practice and Government regulation. Butter must contain not less than 80 per cent butterfat and less than 16 per cent water. Since butterfat is the most valuable and costly constituent of butter, it is good commercial practice to produce a butter having a standard fat content. Since the fat content of butter varies inversely as the other constituents, it is essential that the percentage of water, salt, and curd also be standardized or controlled. This control or standardization can be accomplished without effect upon the quality or score, hence any control has a marked commercial significance in that the quantity of butter obtainable from a definite quantity of butterfat depends upon the fat content of the butter made from it. The commercial value will depend upon the price per pound placed upon the product.

A study of the composition of creamery butter has been made by numerous investigators, among whom are Lee and Barnhart (2), the United States Department of Agriculture and trade organizations. The work of these investigators indicates a wide variation in the water, fat, salt, and curd content of butter.

The study made of Minnesota butter by the writer during the past year indicates a startling lack of control of these constituents and probably a large financial loss to dairy producers.

PLAN OF STUDY.

Samples of butter were obtained from 20-pound tubs, entered in competitive contests, held in Minnesota during the year 1922. Approximately 2,050 samples were thus obtained and analyzed by use of the Kohman method (3) for butter analysis, modified as later described. This resulted in determining the percentage of water, fat, salt, and curd in each sample. A summary of this study indicates the wide variation found, and calculations based on these data, when applied to Minnesota's annual creamery butter crop, indicate the commercial significance of variations in composition of creamery butter.

METHODS USED.

Samples were taken from the 20-pound tubs of butter entered in each contest at the time the butter was scored by the official judges. These samples were obtained by use of a 12-inch butter trier which

drew a plug of butter the full depth of the tub. Two or three such plugs were drawn from each tub perpendicularly, or diagonally, and from portions about two inches apart. Upon removal of the trier containing the plug the loose moisture on the back of the trier was removed before transferring the plug (less 1 inch at the top) to the 4-ounce or half-pint bottle, which was then tightly closed to prevent evaporation. These samples were then stored in a refrigerated room at a temperature of approximately 35° F. until analyzed. The analysis of each lot of samples was usually completed within one month after the contest. The four-ounce bottles were closed with a tightly fitting cork, while the half-pint milk bottles were tightly closed by means of two milk-bottle fiber caps.

These samples were taken from the refrigerated room at time of the analysis. They were softened by setting in a warm water-bath of about 100° F. until they could be easily worked into a homogeneous sample. Ten grams of this thoroughly mixed sample were then used for analysis by means of the Kohman method for butter analysis, modified as follows:

1. Instead of petroleum ether, high-test gasoline was used as the fat solvent.
2. Only one-tenth of the salt solution was titrated with silver nitrate solution.
3. Each cubic centimeter of silver nitrate solution used thus represented 1 per cent salt.
4. The torsion moisture test scale (style 1,700) was used for weighing so the loss in weight could be read from the scale beams as percentage of the 10-gram sample used.
5. A flat-bottomed 250 cubic centimeters aluminum cup was used in making the test.
6. An alcohol flame was used in drying the sample.

RESULTS.

The results obtained from an analysis of approximately 2,050 samples of competitive contest butter are summarized in Table 2, and in Table 3 is shown the summary of analyses of 135 samples of butter, taken from tubs of butter at the creameries by fieldmen of the Minnesota Cooperative Creameries Association, Inc. These samples represent butter packed ready for shipment. Table 4 summarizes the analyses of 47 samples of Minnesota creamery butter as it appeared on the New York market. These results show a wide variation in the constituents of commercial butter. While the variation found in the contest butter is greater than that in the samples obtained from the fieldmen, and from the New York market, it is believed that this is explainable and due to the larger number of samples from contest sources.

TABLE 2.—*Summary of analyses of butter samples, arranged by months.*

Month and number of samples and constituent.	Maximum.	Minimum.	Average.	Number of samples and color on Nafis rod.	Storch test (1) for peroxidase.
May, 264 samples:					
Water.....	20.2	11.4	14.699	147 A	} Not deter- mined.
Fat.....	87.1	76.7	82.580	85 B	
Salt.....	3.6	.6	1.959	23 C	
Curd.....	1.9	.2	.762	6 D	
June, 295 samples:					
Water.....	24.2	11.0	14.8	39 A	160+
Fat.....	87.1	73.5	82.7	227 B	38±
Salt.....	4.1	.4	1.9	24 C	82—
Curd.....	1.8	.3	.7	3 D	² 15
July, 183 samples:					
Water.....	20.8	10.7	14.21	32 A	94+
Fat.....	87.7	77.1	83.13	141 B	39±
Salt.....	3.9	.5	1.87		50—
Curd.....	1.7	.3	.79		
August, 242 samples:					
Water.....	18.5	10.4	13.80	110 A	60+
Fat.....	87.6	78.5	83.29	120 B	31±
Salt.....	3.4	.3	1.62	9 C	151—
Curd.....	2.5	.3	1.08	3 D	
October, 448 samples:					
Water.....	17.9	9.8	13.567	273 A	³ 208+
Fat.....	88.0	78.2	83.930	313 B	77±
Salt.....	3.8	.1	1.594	31 C	319—
Curd.....	2.2	.2	.985	3 D	
November, 418 samples:					
Water.....	24.1	9.2	13.56	180 A	114+
Fat.....	88.8	70.6	83.44	253 B	60+
Salt.....	3.7	.5	1.74	53 C	244—
Curd.....	1.9	.3	.82	2 D	
January, 200 samples:					
Water.....	20.1	9.3	13.096	58 A	30+
Fat.....	88.9	77.1	84.120	129 B	27±
Salt.....	3.7	.6	1.880	11 C	143—
Curd.....	2.5	.4	.760	2 D	
Summary for the year, 2,050 samples:					
Water.....	24.2	9.2	13.926	839 A	666+
Fat.....	88.9	70.6	83.346	1,268 B	272±
Salt.....	4.1	.1	1.770	151 C	989—
Curd.....	2.5	.2	.852	19 D	

¹ + indicates positive result within 10 seconds; ± indicates positive result after 10 seconds and within 30 seconds; — indicates negative results for 30 seconds or more.

² No report.

³ 153 samples tested for peroxidase but not analyzed.

It will be noted from data submitted in Table 2 that the variation in composition of butter was essentially the same at each season of the year, rather indicating that this variation is due to lack of effort toward control rather than to any seasonal reason. The fact that butter entered in these competitive contests is judged entirely upon a quality basis, rather than upon a basis of composition, may have resulted in neglect of usual composition control work, and may have caused the samples analyzed to be not truly representative of the butter entering the regular commercial trade. To obtain experimental evidence or definite data with reference to this particular point, surprise samples were collected at 135 creameries throughout the State of Minnesota by dairy specialists. These samples were obtained, handled, and tested under as nearly as possible the same conditions as the contest samples. The analytical data summarized in Table No. 3 show essentially the same variation and lack of control as the contest samples.

TABLE 3.—*Summary of analyses of surprise call butter samples obtained at time of shipment from Minnesota creameries.*

Source, time, number of samples, and constituents.	Maximum.	Minimum.	Average.	Number of samples and color on Nafis rod.	Storch test ¹ for peroxidase.
Fieldmen, winter, 135 samples:					
Water.....	18.6	11.6	15.025	48 A	62+
Fat.....	85.7	76.3	81.774	70 B	10±
Salt.....	5.2	.8	2.350	11 C	62-
Curd.....	3.5	.4	.850	26	2 1

¹ See footnote 1, Table 2.² No report.

In order to obtain additional data concerning the composition of butter as it appears in the market, surprise samples were taken from Minnesota butter on the New York market in February, 1923. Forty-seven samples were thus obtained and analyses made. The result was as shown in the following summary in Table 4:

TABLE 4.—*Summary of analyses of surprise samples from Minnesota butter on the New York market.*

Source, time, number of samples, and constituents.	Maximum.	Minimum.	Average.	Storch test ¹ for peroxidase.
New York market, February, 47 samples:				
Water.....	17.0	11.0	14.03	16+
Fat.....	86.8	79.5	82.97	6±
Salt.....	4.4	1.0	2.16	25-
Curd.....	1.3	.3	.77	.....

¹ See footnote 1, Table 2.

These samples show essentially the same lack of control as was evidenced in the contest samples and those obtained from the creameries at the time the butter was packed and ready for shipment.

The striking similarity of results from the samples of butter from the three different sources is more clearly shown by making the comparison on a percentage basis. Such a comparison will also indicate something with reference to the lack of efficiency and probable commercial loss, due to the failure upon the part of butter manufacturers to control more carefully the fat content of butter. Table No. 5 summarizes the results on a percentage basis.

TABLE 5.—*Comparative summaries with reference to butter fat and water content of butter samples.*

Source and number of samples.	Samples containing—			
	16 per cent water or above.	Less than 80 per cent fat.	Between 80 and 81 per cent fat.	Above 81 per cent fat.
Competitive contest, 2,050 samples:				
Number of samples.....	152	60	109	1,881
Percentage of all samples.....	7.414	2.927	5.219	91.756
Minnesota creameries, 135 samples:				
Number of samples.....	28	18	22	95
Percentage of all samples.....	20.741	13.333	16.296	70.371
New York market, 47 samples:				
Number of samples.....	3	1	4	42
Percentage of all samples.....	6.383	2.123	8.511	89.361

These results show a striking similarity, which is especially true in the case of the contest samples and those obtained from the New York market. The samples from the creameries no doubt would, if taken from the butter after arriving on the market, probably have shown a decrease in the percentage containing 16 per cent water or above, and also in the percentage showing less than 80 per cent and between 80 and 81 per cent fat, while an increase in the percentage above 81 per cent would have occurred. This change during transportation and handling would be due to leakage and evaporation.

A more detailed summary with reference to the fat content found in 2,049 samples of the contest butter is shown in Table 6.

TABLE 6.—*Summary of contest samples.*

Percentage of fat between—	Per cent.	Percentage of fat between—	Per cent.
70 and 78.....	0.293	83.1 and 84.....	21.327
78.1 and 79.....	.781	84.1 and 85.....	20.839
79.1 and 80.....	1.952	85.1 and 86.....	12.884
80.1 and 81.....	4.685	86.1 and 87.....	5.857
81.1 and 82.....	10.737	87.1 and 88.....	1.659
82.1 and 83.....	18.302	88.1 and 89.....	.683

The limits of this paper will not permit data in more detail than are here offered, but, applying the analyses of contest butter to the 170,000,000 pounds of butter produced in Minnesota annually, they indicate that if butter were carefully standardized to 80 per cent butterfat, other conditions permitting, the additional return for butter in the State, due to increased yield through composition control, would, at 36 cents per pound, exceed \$2,000,000 annually.

CONCLUSIONS.

1. Briefly stated, it seems probable that the commercial value of the variable constituents of creamery butter exceeds \$10,000,000 annually on each 170,000,000 pounds of butter produced, unless careful control methods are followed.

2. The quality of butter depends upon minute quantities of substances which, to a large extent, still baffle the chemist and bacteriologist.

3. The price of butter is dependent upon its quality, or score, and market demand.

4. During 1922, the average prices for butters scoring 93, 92, 91, 90, 89, 88, 87, and 86, were, respectively, 41.29, 40.52, 39.40, 37.75, 36.29, 35.30, 34.00, and 32.40 cents per pound.

5. The best data available indicate the percentages of all butter scoring 93, 92, 91, 90, 89, 88, 87, and 86 were, respectively, 2, 3, 10, 20, 25, 25, 10, and 5.

6. These averages, when applied to 170,000,000 pounds of butter, indicate a probable loss of approximately \$8,000,000 per year, due to poor quality.

7. The composition of butter varies widely. Analyses of 2,050 samples showed the water varied between 24.2 per cent and 9.2 per cent; the fat between 88.9 and 70.6 per cent; the salt between 4.1 and 1.9 per cent; the curd between 2.5 and 0.2 per cent; and the color from A to D on the Nafis color rod.

8. Similar variation was found in samples of butter from three sources studied, viz, competitive contests, creameries, and New York market.

9. These analyses indicate that a considerable portion of American creamery butter contains fat above the legal and market requirements, and if typical of all butter produced in creameries, means a tremendous loss to the dairy industry.

10. This loss when applied to 170,000,000 pounds, the annual output of Minnesota creameries, amounts to more than \$2,000,000 per year.

11. The loss to the dairy industry of the United States, due to poor quality and poorly controlled composition, may approximate \$60,000,000 annually.

12. Control of composition is probably easier than control of quality because it is centered in the hands of fewer men.

13. The variable constituents of creamery butter are of great commercial significance. Steps should be taken to control them in every butter-producing country.

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THE IMPORTANCE OF THE EQUILIBRIA IN THE SYSTEM MILK FAT IN THE MAKING OF BUTTER.

WILLEM VAN DAM, Ph. D., director of the chemical department of the State Agricultural Experiment Station at Hoorn, Holland.

The researches by Fleischmann on the specific heat of milk and cream and those by Fleischmann and Wiegner on the changes that take place in the specific gravity of milk when it is left to stand and cool, and, especially, Rosengren's findings on a low temperature souring in making butter, have all proved that the fat of the fat globules begins to solidify at much higher temperatures than was formerly supposed. These earlier suppositions were based, chiefly, on Soxhlet's contentions that solidification begins only at a temperature near the freezing point of water. We now know that it sets in at temperatures varying between 20° C. (or even higher) and about 16° C., and that the solidification proceeds as the temperature is lowered and the time of the cooling is increased. From the fact that the butter becomes firmer the longer we expose the cream to that temperature, it follows that the solidification of the fat globules is a slow process which leads to a definite state of equilibrium dependent on the temperature.

If we expose the cream to the influence of a temperature of 11° to 12° C. for 20 to 24 hours, as, according to Rosengren, is sometimes done in summer in souring at a low temperature, we get nearer and nearer to the condition of equilibrium corresponding to that temperature; the approach to it is rapid at first and then slower and slower.

At the end of the time we are unable to tell how near we have reached that condition of equilibrium, nor do we know if the failure to reach it has any appreciable effect on the result of the churning process and, particularly, on the solidity of the butter and on the amount of fat in the buttermilk.

The well-known facts that cooling to a still lower temperature has a favorable effect on the result of the churning, and churning at the same temperature as in cooling the cream to 11° or 12° C., make it likely that the producing of a complete state of equilibrium in the milk fat before churning must also have a favorable effect. It is therefore important to the butter maker to know whether or not the usual time and temperature of souring produce a practically complete solidification of the fat. By means of some comparatively simple experiments, I have succeeded in gaining some insight into this matter.

As the solidification is accompanied with changes of volume we can, by measuring the latter with the help of dilatometers, check the amount of the solidification at any definite temperature. If a dilatometer be filled with very rich cream the fat of which has been brought into the liquid state by previous heating to about 40° C., and the apparatus be then placed in a thermostat adjusted to 11° C., it will be found after 24 hours that the volume has not by any means become constant, nor will it be found to be so even after twice that length of time. The solidification is still proceeding slowly. That no state of equilibrium is thus reached may be proved in a very clear manner by the following experiment.

Two dilatometers were filled with cream whose fat globules were still in the liquid state. One was placed in a bath of 0° C., the other in a bath of 7° C., and they were kept in the baths for 21 hours. The question was: Does the system milk fat reach the state of equilibrium in 21 hours? The answer was found by heating and measuring the expansion of the cream in the two dilatometers at successive degrees of temperature. If there was equilibrium at 7° C. we might expect to find the same expansion in both cases. In Table 1 the result of such an experiment is given. The expansions are expressed in ten-thousandth parts of milk by volume.

TABLE 1.—*Effect of previous cooling on the expansion of cream in heating.*

Heated from—	Expansion in ten-thousandth part volume.		Heated from—	Expansion in ten-thousandth part volume.	
	Cooled to 0° C. for 21 hours.	Cooled to 7° C. for 21 hours.		Cooled to 0° C. for 21 hours.	Cooled to 7° C. for 21 hours.
° C.			° C.		
8-10	15.6	11.7	15-16	11.2	10.7
10-11	8.6	6.2	16-17	9.6	9.9
11-12	10.5	7.4	17-18	9.7	10.2
12-13	10.7	7.8	18-19	9.9	10.0
13-14	11.0	9.0	19-20	8.5	9.1
14-15	11.2	9.5	20-24	31.0	31.2

These figures prove clearly that the expansions of the cream which was cooled to 7° C. are smaller at first than those of the cream which

was cooled to a lower temperature. Evidently the changes of condition in the former case have not reached the state of equilibrium. Not till the temperature has risen to from 15° to 16° C. do the expansions run parallel, and we may therefore assume that the cream which was cooled to 7° C. has first to be heated to 16° C. in order to reach the state of equilibrium equivalent to that of the cream cooled to a lower temperature.

Table 2 shows the results of a similar experiment made with cream which was kept at from -15 to -10° C. and cream which was kept at 0° C.

TABLE 2.—*Effect of previous cooling on the expansion of cream in heating.*

Heated from—	Expansion in ten-thousandth part volume.		Heated from—	Expansion in ten-thousandth part volume.	
	Cooled to from -15° to -10° C. for 21 hours.	Cooled to 0° C. for 21 hours.		Cooled to from -15° to -10° C. for 21 hours.	Cooled to 0° C. for 21 hours.
$^{\circ}$ C.			$^{\circ}$ C.		
6-7	7.7	5.5	10-11	9.5	8.8
7-8	8.5	6.2	11-12	10.5	10.5
8-9	9.1	7.2	12-13	10.0	10.0
9-10	9.7	8.4			

Here again the figures prove that the expansions of the cream which was cooled to 0° C. do not become equal to those of the much colder cream till a temperature of 10° to 12° C. has been reached. Above 12° C. the expansions of the two creams run parallel again. The results of a number of similar experiments permitted us to draw the conclusion.

To get the cream fat in a state of equilibrium at the temperature at which the cream is to be churned, a long time of previous cooling is required to a temperature which is about 10° C. lower.

It follows, amongst other things, that the churning of cream which is soured at, say, 11° C. for 24 hours, may still have some effect on the physical condition of the milk fat: The solidification of the fat may proceed further through the churning and the consequent coalescence of the fat globules. If before the souring the cream is cooled to 0° C., for 24 hours, further solidification will, if the cream is churned at 11° C., be impossible because the condition of equilibrium has already been reached. This, too, was proved by the dilatometric method.

It is in the interest of the practice of butter making to ascertain if the results of the churning are in any way dependent on whether or not the condition of equilibrium has been reached in the milk fat before the churning begins. A priori we may say that the effect of a slight raising of the churning temperature on cream, the fat of which is in a state of equilibrium, must differ from that on other cream fat. In the former case the raising of the temperature will lead to a new equilibrium corresponding to the higher temperature, whereas in the latter case the slightest raising of the churning temperature will hinder the effect of the churning; i. e.,

the further solidification, which proceeds the slower the higher the temperature becomes. We will not now go into the question if this slowing down of the process is due to a diminishing of the rapidity of the solidification or to a slower formation of nuclei from which the crystallization can radiate.

Presumably the latter is the case. The firmness of the butter will certainly be more impaired by raising the churning temperature if the solidification is not complete before churning, than if the state of equilibrium has already been reached.

That the time required for the churning and the amount of fat in the buttermilk are variously influenced by the raising of the temperature, according to whether the state of equilibrium has or has not been reached beforehand, is shown by the following churning experiments.

After Pasteurizing, the cream was cooled to 0° C. for 24 hours. Half of it was then heated to 40° C. to melt the fat globules. The two portions were then raised and lowered, respectively, to the souring temperature in such a way that the colder cream did not come into contact with water that was above the souring temperature and the other, heated cream, did not come into contact with water that was below that temperature. The two portions were then soured for about 21 hours and churned at various temperatures in a precision churn which had been placed in a thermostat. In Table 3 we give the results of one of a great number of experiments.

TABLE 3.—*Difference in the effect on the churning process, resulting from the raising of the churning temperature, when cream fat was, or was not, in a condition of equilibrium before churning.*

[First experiment: Amount of fat, 19 per cent; souring temperature, 13° C.; degree of acidity, 75 to 76, $\frac{1}{10}$ normal.]

Condition of fat. ¹	Churning temperature.		Period of churning.	Percentage of fat in the buttermilk.
	Starting.	End.		
	° C.	° C.	Minutes.	
C.....			63	0.24
W.....	13	13.2	75	.50
C.....			41	.27
W.....	14.5	14.6	68	.62
C.....			27	.36
W.....	16	16.2	59½	.80
C.....			20	.51
W.....	17.5	17.65	48½	1.20
C.....			13	.62
W.....	19	19	(?)	.....

¹ C=Fat in a state of equilibrium; W=fat not in state of equilibrium.

The difference in the time required for the churning and in the amount of fat in the buttermilk appears very clearly. The experiment was made in May when the cows produced very soft fat. Table 4 gives the results of another experiment in which cream containing hard fat was used.

TABLE 4.—*Difference in the effect on the churning process, resulting from the raising of the churning temperature, when cream fat was, or was not, in a condition of equilibrium before churning.*

[Second experiment: Amount of fat, 16.5 per cent; souring temperature, 11° C.; degree of acidity, 71, $\frac{1}{10}$ normal.]

Condition of fat. ¹	Churning temperature.		Period of churning.	Percentage of fat in the buttermilk.
	Starting.	End.		
	° C.	° C.	Minutes.	
C.			142	0.28
W.	11	11.20	157	.33
C.			80	.30
W.	13	13.20	115	.43
C.			44	.37
W.	15	15.20	83	.53
C.			25	.60
W.	17	17.15	43	.98
C.			16	.92
W.	19	19	(?)	.....

¹ C= Fat in a state of equilibrium; W=fat not in state of equilibrium.

Here again the difference comes out very clearly. The large number of experiments made in this way proved, without a single exception, *that with all the variations of the churning temperature the C cream always gave the smaller amount of fat in the buttermilk and that the increase of the amount of fat produced by the raising of the temperature is smaller in the case of C cream than of W cream.*

CONCLUSIONS.

For any temperature at which the cream is churned, the rule holds that a minimum amount of fat will go into the buttermilk only if, before churning, a state of equilibrium has been produced in the system milk fat.

In order to be quite certain that this state of equilibrium has been brought about, the cream must be cooled for a considerable length of time to about 10° C. below the churning temperature.

Raising the souring and the churning temperature has less injurious effect on the amount of fat in the buttermilk and consistency of the butter when the state of equilibrium has first been produced in the milk fat than when this has not been done.

Cooling to a very low temperature by which the loss of fat in the buttermilk is diminished and by which the butter maker is enabled to sour at a higher temperature and to produce a firmer butter, is in every way recommendable in summer in the Netherlands.

DIE ENTSTEHUNG DER BUTTER.

OTTO RAHN, Ph. D., Vorsteher des physikalischen Instituts der preussischen Versuchs- und Forschungsanstalt für Milchwirtschaft, Kiel, Preussen.

Die Butterbildung beim Verarbeiten von Rahm wird von den Milchwirtschaftlern noch fast ausschliesslich durch die Soxhlet'sche Theorie (17) erklärt, obschon man seit mehr als 20 Jahren weiss, dass manche Tatsachen damit in Widerspruch stehen. Soxhlet nahm an, dass das Fett in den Fettkügelchen des Rahms auch bei

guter Kühlung flüssig bleibt, dass es erst durch die starke Bewegung im Butterfass fest wird und dadurch erst die Fähigkeit erlangt, zusammenzukleben. Inzwischen ist durch verschiedene Forscher (Storch (18), Hittcher (6), Rahn (11)), gezeigt worden, dass man noch bei 30° C. und darüber buttern kann, dass also auch bei flüssigem Fett noch Butterbildung stattfindet. Ferner haben Fleischmann (3) Fleischmann und Wiegner (4) sowie van Dam (1) gezeigt, dass das Fett im Rahm bei Temperaturen unter 15° C. allmählich fest wird. Da die Voraussetzungen der Soxhlet'schen Theorie sich als unrichtig erwiesen haben, so können auch die Schlussfolgerungen nicht richtig sein.

Man ist sich jetzt einig darüber, dass die Fettkügelchen der Milch durch die Oberflächenspannung voneinander getrennt gehalten werden. Es bleibt nun zu erklären, wie diese Kraft durch die mechanische Bearbeitung des Rahmes überwunden wird. Die Annahme von Hunziker (8), dass das Festwerden des Fettes in den Kügelchen die Oberflächenspannung aufhebt, ist nicht bewiesen, sie ist auch zu allgemein, denn dann würde ja die Bildung von Schlagsahne unmöglich sein.

Es ist nicht selbstverständlich, dass sich beim Schlagen des Rahms Butter bildet. Es gibt Rahm, der sich nicht verbuttern lässt. Schon im Jahre 1902 hat Siedel (13) solchen Rahm hergestellt, indem er Vollmilch bei tiefer Temperatur etwa eine Stunde butterte und dann entrahmte. Die Magermilch schäumte nicht und der Rahm gab keine Butter. Diese Beobachtung ist neuerdings im Grossen durch Hesselberg (5) bestätigt worden. Buttermilch von Süssrahmbutter wird oft entrahmt, um das Fett wiederzugewinnen. Der so erhaltene Buttermilchrahm lässt sich aber nicht direkt verbuttern.

Zu diesen Beobachtungen, die schon auf eine Beziehung zwischen Schaumbildung und Butterbildung hinweisen, kommt noch die bekannte Tatsache, dass der Rahm beim Buttern schäumt, und dass die Butterkörnchen auftreten, sobald der Schaum zusammengefallen ist. Da nun das Schäumen eine Folge von Oberflächenkräften ist, so ist es wahrscheinlich, dass die Oberflächenspannung eine wichtige Rolle bei der Butterbildung spielt.

Die Oberflächenspannung der Milch ist kleiner als die des Wassers. Wir wissen nicht genau, welchen Anteil jeder einzelne der Milchbestandteile hat, aber wir wissen, dass die Eiweissstoffe den grössten Anteil daran haben, da Fett, Zucker und Mineralien die Oberflächenspannung nur wenig verändern. Nach dem Gesetz von Gibbs-Thomson müssen diejenigen Stoffe, welche die Oberflächenspannung erniedrigen, sich an den Grenzflächen anreichern. Wir wollen der Einfachheit halber annehmen, dass nur ein Stoff der Milch die Oberflächenspannung erniedrigt. Tatsächlich hat Ramsden (12) gezeigt, dass bei gleichzeitiger Anwesenheit von zwei oberflächenaktiven Stoffen nur einer sich in der Oberfläche anreichert und den anderen verdrängt. Dieser eine Stoff, aller Wahrscheinlichkeit nach ein Eiweissstoff, ist also an den Grenzflächen in stärkerem Mass vertreten. So erklärt sich die Bildung der Milchhaut beim Erwärmen und auch das Ansetzen und das leichte Anbrennen der Milch beim Kochen.

Die Milch hat aber noch eine viel grössere innere Grenzfläche gegen die vielen Fettkügelchen, deren Gesamtoberfläche sich auf wenigstens 25 bis 30 m² im Liter Milch berechnet; sie ist also mehrere

hundert Mal so gross als die äusseren Grenzflächen. Auch hier muss nach dem Gesetz von Gibbs-Thomson eine Anreicherung des hypothetischen Stoffs stattfinden, und diese Anhäufung lässt sich analytisch nachweisen. Rahm enthält etwas mehr stickstoffhaltige Stoffe als die zugehörige Magermilch, wenn man auf fettfreie Lösungen umrechnet. Noch stärker ist die Eiweissanhäufung, trotz des Waschens, in der Butter.

TABELLE I.—Stickstoffsubstanzen in 100 Teilen fettfreier Lösung.

Milch.	Rahm.	Butter.	Anzahl Versuche.	Versuchsansteller.
<i>Prozent.</i>	<i>Prozent.</i>	<i>Prozent.</i>		
3.39	3.47	.....	9	Höft (7).
3.25	3.31	3.76	12	Siedel (15).
3.29	3.32	4.98	5	Siedel (13).
.....	3.26	4.25	7	Siedel (13).

Genauere Angaben hierüber findet man auch bei van Dam und Sirks (2).

Die Stoffe, welche sich um die Fettkügelchen herum anreichern, sind vermutlich nicht so dicht angehäuft, dass sie als feste Körper ausgeschieden werden, sondern sie bilden eine zähflüssige klebrige Hülle um das Fett. Die Schicht ist viel zu dünn, um mikroskopisch sichtbar zu sein, aber sie macht sich deutlich bemerkbar durch ihre Klebkraft. Die Fettkügelchen der Milch haben starke Neigung, zusammenzukleben, und die schnelle Rahmbildung in Milch ist nur dadurch zu erklären, dass die Fettkügelchen sich zusammenballen und in grösseren oder kleineren Haufen schnell emporsteigen. (Rahn (9) van Dam und Sirks (2).) Durch das Erhitzen verliert dieser Stoff seine Klebkraft, in erhitzter Milch liegen alle Fettkügelchen einzeln, und dadurch erklärt sich das langsame Aufrahmen erhitzter Milch, weil jedes Fettkügelchen einzeln die Reibung überwinden muss.

Der Stoff, welcher die Oberflächenspannung der Milch erniedrigt, ist auch die Ursache des Schäumens. Vollmilch, Rahm, und Magermilch schäumen stark, der Vollmilchschaum ist wenig haltbar, der Magermilchschaum ist etwas beständiger, am dauerhaftesten ist die Schlagsahne. Das Schäumen ist die Folge der erniedrigten Oberflächenspannung. In den Schaumbläschen mit ihrer stark vergrösserten Oberfläche muss sich nun wieder derjenige Stoff anreichern, der die Oberflächenspannung erniedrigt. Auch dies ist durch einige Analysen von Siedel und Hesse (16) bewiesen.

TABELLE II.—Analysen von Magermilch und deren Schaum.

	Stark schäumende Milch, 9 Versuche.				Schwach schäumende Milch, 6 Versuche.			
	Eiweiss.	Fett und Zucker.	Asche.	Trockenmasse.	Eiweiss.	Fett und Zucker.	Asche.	Trockenmasse.
	<i>Prozent.</i>	<i>Prozent.</i>	<i>Prozent.</i>	<i>Prozent.</i>	<i>Prozent.</i>	<i>Prozent.</i>	<i>Prozent.</i>	<i>Prozent.</i>
Schaum.....	3.51	4.73	0.78	9.02	3.24	4.92	0.76	8.92
Milch.....	3.09	4.85	.75	8.69	3.01	4.92	.74	8.67

Im Schaum findet man also eine Zunahme der Trockenmasse; es haben aber nicht alle Milchbestandteile gleichmässig zugenommen sondern nur die Eiweissstoffe, welche die Oberflächenspannung erniedrigen, während Fett, Zucker, und Asche gleich geblieben sind.

Die Schaumwände der Milch werden allmählich fest. Es kann vorkommen, dass alle Schaumblasen zerplatzen, ehe die Wände fest werden, besonders bei Vollmilch. Oft aber bleibt ein Teil des Schaums stehen, wenn man ihn vorsichtig behandelt, und die mikroskopische Untersuchung zeigt dann, dass die Schaumwände fest sind. Die Blasen sind zum Teil schon zerbrochen und zeigen grosse Löcher, aber die Wände bleiben trotzdem stehen. Solch trockner Schaum hält sich unbegrenzt. Auch bei Schlagsahne wird die Flüssigkeit der Schaumwände allmählich fest; darauf beruht das Nachdicken der geschlagenen Sahne.

Nach diesen Vorstudien erklärt sich die Butterbildung recht einfach. Beim Buttern wird in jedem Butterfass viel Luft in den Rahm gemischt, sodass eine Kräftige Schaumbildung bewirkt wird. Der hypothetische Stoff, der die niedrige Oberflächenspannung der Milch verursacht, wird sich in den Schaumblasen ansammeln. Da dieser Stoff aber um die Fettkügelchen herum gelagert ist, so werden die Fettkügelchen mit in den Schaum hineingerissen. Siedel (14) stellte fest, dass noch ehe der Schaum zusammenfällt, fast das gesamte Fett des Rahms im Schaume sich befand, während der flüssige untere Rahm nur noch 2.75 Prozent Fett enthielt.

Die Fettkügelchen liegen in dem äusserst fettreichen Schaum sehr dicht aneinander, sie werden auch durch den Druck in den dünnen Schaumwänden zwischen zwei Oberflächen zusammengedrückt. Es bilden sich also zunächst Haufen von Fettkügelchen, die man mikroskopisch leicht feststellen und zählen kann, und dann werden bei genügend weichem Fett, die Fettkügelchen so ineinandergedrückt, dass die Haufen in Klumpen verwandelt werden. Ob die Oberflächenkräfte allein schon hierzu ausreichen, oder ob das Schlagwerk oder Rührwerk die notwendige Kraft liefert, konnte noch nicht festgestellt werden. Es soll hier aber erwähnt werden, dass mehrere Luftbutterfässer gebaut worden sind, in denen der Rahm ausschliesslich dadurch gebuttert wurde, dass man Luft durch den Rahm presste.

Das Zusammenfallen des Schaums kann man dadurch erklären, dass die Klümpchen so gross werden, dass das Gleichgewicht der Kräfte in den Schaumbläschen gestört ist (Hunziker (8)). Diese Auffassung erklärt aber nicht die Beobachtung, dass nun die Buttermilch wenig schäumt und der Buttermilchsrahm sich nicht mehr verbuttern lässt. Es ist offenbar mit dem Schaumstoff eine Veränderung vorgegangen, und es ist das Nächstliegende anzunehmen, dass der Schaumstoff fest geworden ist.

Diese Theorie der Butterentstehung erklärt manches, was die Soxhlet'sche Theorie unerklärt liess. Zusätze von Seife, Alkali, oder Ammoniak in kleinen Mengen verzögern das Buttern oder verhindern es vollständig, da sie die Hülle der Fettkügelchen so verändern, dass sie nicht mehr zusammenkleben. Zucker, Alaun, Gummi, Leim, Spiritus, oder Mehl schaden in kleinen Mengen nicht, da sie die Oberflächenspannung nicht wesentlich beeinflussen.

Auch der höhere Fettgehalt der Buttermilch bei höherer Buttermischungswärme ist hierdurch leicht verständlich. Je weicher das Fett, um so schneller bildet sich im allgemeinen die Butter. Wenn sich die Butter schnell bildet, besteht die Gefahr, dass der Schaum zusammenfällt, ehe alles Fett in den Schaum gelangt ist. Nach dem Zusammenfallen des Schaumes besteht keine Möglichkeit mehr, die einzelnen Fettkügelchen noch zu sammeln. Deswegen ist eine schnelle Butterbildung nicht wünschenswert. In Anschluss hieran sei noch auf die merkwürdige Beobachtung von van Dam (1) hingewiesen, dass unter bestimmten Umständen ein hartes Fett schneller ausbuttern kann als ein weiches Fett.

Diese Theorie der Butterbildung ist nicht als etwas Vollkommenes und Fertiges anzusehen. Sie ist vielmehr nur der erste Schritt in einer neuen Richtung. Zunächst ist sie für die Molkereipraxis wichtig als Arbeitstheorie, da sie alle normalen Erscheinungen und auch einige Butterfehler gut erklärt. Der theoretische Ausbau wird noch umfangreiche Arbeiten erfordern

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[Abstract.]

THE FORMATION OF BUTTER IN CHURNING.

OTTO RAHN, Ph. D., head of physics department, Prussian Dairy Research Institution, Kiel, Germany.

Soxhlet's old churning theory, dating from 1876, is based upon assumptions which have proved, in the course of time, to be wrong. Soxhlet supposed that the fat of the cream remained liquid, that liquid fat globules did not stick together, and that the concussion in the churn was necessary to solidify the fat and thus form the butter. Since then it has been shown that the fat of normally cooled cream is solid before the churning begins, and that even liquid fat at 32° C. may be transformed into butter.

The theory here advanced tries to explain the formation of butter through surface forces. Milk has a lower surface tension than water, largely on account of certain proteins. According to the law of Gibbs and Thomson, the substances reducing the surface tension must accumulate in the surfaces. The largest surface of milk is that against the fat globules which amounts to at least 25 to 30 m² per liter. The fat globules must be surrounded by a very thin film of protein, and this has been proved analytically by the higher nitrogen content of cream and butter as compared to milk. The protein films of the fat globules are not solid, but viscous, and they cause a natural gathering of the fat in raw milk. These accumulations bring about the rapid formation of cream, while in heated milk all globules remain single and therefore rise but slowly.

Another kind of surface originates in the milk foam. The proteins must accumulate in these foam membranes as well, and analysis proves, indeed, that the milk foam contains more protein than the milk itself.

The formation of butter may be explained as follows: In churning, air is dispersed in the cream, and a foam is formed. The protein lowering the surface tension must accumulate in the newly produced surfaces, i. e., the foam membranes, and since this same protein surrounds the fat globules, these are drawn into the foam and held there. Analysis shows that the liquid cream underneath the foam is gradually decreased in fat. In the foam, the fat globules lie very close together, under the pressure of the two surfaces, and thus fat clusters originate at first. These clusters are readily transformed into lumps if the fat is soft enough to yield to the pressure, and these lumps stick together and thus rapidly increase in size. Finally the butter "breaks," the foam collapses, either because the butter lumps become so large as to disturb the surface equilibrium, or because the protein in the foam membranes solidifies and thereby loses its elasticity.

All substances influencing the surface tension of milk, or changing the films of the fat globules as, for example, alkali, retard or inhibit the churning. The high fat content of buttermilk at high churning temperatures is caused by too rapid a formation of butter lumps before all the fat globules have been worked into the foam.

SESSION 21. MILK SECRETION AND THE NUTRITION OF DAIRY COWS.

Honorary chairman, E. W. LANGFORD, past president and chairman of the milk and dairy produce committee, National Farmers' Union of England and Wales.

Chairman, H. W. JEFFERS, president, Walker-Gordon Laboratory Co., Plainsboro, N. J.

Secretary, C. H. WILLOUGHBY, professor of animal husbandry, University of Florida.

FIRST BAPTIST CHURCH AUDITORIUM,
Syracuse, N. Y., Tuesday, October 9, 1923—9.30 a. m.

Chairman JEFFERS. The meeting will please come to order.

Doctor Porcher, who was to have been our honorary chairman, can not be here. He had to leave for Paris to-day, and we have asked Mr. Langford to act in his place. Mr. Langford is from England and is past president of the National Farmers' Union of England and Wales.

I will ask him to make a few remarks.

Mr. LANGFORD. Mr. Chairman, ladies, and gentlemen: It is indeed a great pleasure to be with you this morning.

In my opinion this session on milk secretion and the nutrition of dairy cows is the most important session of the Dairy Congress. I will therefore not consume any more time this morning, but wish to thank you for this opportunity of appearing before you. It is a great pleasure, and I hope that during the session each and every one of us will get a great deal of good from what we hear. I thank you very much. [Applause.]

Chairman JEFFERS. The first paper was to have been read by Doctor Porcher. The secretary has an announcement to make regarding that.

Secretary WILLOUGHBY. As already announced, Professor Porcher was compelled to leave early this morning to catch a steamer which leaves New York sooner than he anticipated. He has to return to Paris for the purpose of beginning a series of 20 lectures on milk secretion. We regret very much his inability to be with us. He has been a very valuable contributor to our work, and his paper will be read by Prof. Louis Landre, of Syracuse University.

Professor LANDRE. Professor Porcher asks you to excuse him for not being present at this meeting. He regrets this sudden change in his plans, and asks me to say to his colleagues that he will welcome your correspondence in reference to his paper on "The physiology of milk secretion."

(Professor Landre then presented Doctor Porcher's prepared paper.)

THE PHYSIOLOGY OF MILK SECRETION.

CHARLES PORCHER, D. Sc., chief, department of physics, chemistry, pharmacology, and toxicology of the National Veterinary School, Lyons, France.

It is very strange to find that so important a liquid as milk, coming from a gland as accessible to experimentation as the mammary gland, a useful gland, but not necessary to the individual, has a physiology inadequately treated in scientific literature, whether we inquire about the gland itself or about the process of secretion.

It is necessary, I believe, to find the cause of this lack of information in the fact that we have not been sufficiently guided in our researches by the physiological point of view, and also in that the investigators have faced the problem presented to them only in a very narrow way.

The similarity of the mammary secretion in all species renders its study particularly interesting, and the available experimental material which can be used is consequently much enlarged.

I think that a rational physiological study of the lacteal secretion requires, for completeness, and above all for productive results, that one should take into account, as far as possible, the following three things:

(1) The source of the nutritive supply of the gland, that which brings to it all the necessary elements to make milk, namely, the blood.

(2) The transforming mechanism itself, namely, the mammary tissue.

(3) The secreted liquid, namely, the milk.

In the establishment of these chemical and physiochemical relations existing between the milk and the blood in the biochemical examination of the mammary gland, until now too much ignored, we shall be able to find a sufficient number of elements to allow us to establish a plan for research productive of results, in the study of interesting problems in the physiology of milk secretion.

My aim in this paper is not to report all that has been done in that field, but principally to show some of the lines of work in research that might be investigated in order to bring enlightenment on certain points.

In the examination of the blood during the period of lactation, it is possible for us to say that few experiments from a chemical point of view have been conducted for studying the modifications which the blood can undergo in this period. It would be interesting to know what changes in concentration take place in the phosphorus, calcium, potassium, amino acids, and fatty acids. I have shown the variation of glucose in the blood at the time of calving. In collaboration with my colleague, Professor Terroine, I have begun investigations on the quantity of fatty acids in the blood during the lactation period. We are guided by the idea that there must be a parallelism between the proportions of fatty acids in the blood and that of these fatty acids or butterfat in the milk secretion.

The answer to a question of the greatest interest depends on such studies. We all know that the power to produce butterfat in milk is strictly individual, and that it is transmitted by heredity.

Previous experiments by Terroine have shown, in connection with the canine species, that the average richness in fatty acids in the blood varies from one individual to another. The blood of some is, therefore, richer in fats than that of others. Hence, it is only a step to conclude that the same thing may be true of the bovine species; and when we speak of the "blood," considering it especially from the hereditary point of view, we see all of the importance that this notion may acquire from the chemical point of view. It would be interesting to find out whether the cows whose milk has a high percentage of butterfat have blood equally high in fatty acids.

The chemical study of the mammary tissue has not yet been attempted in a systematic way. I do not know of any work in which the mammary tissue itself has been studied, either in the state of rest or when active. Are there differences in that regard? What are they? What changes take place in the mineral constituents? These are questions for which we have no answer.

The hydrolysis of the mammary tissue has not yet been attempted. It would be interesting to endeavor to ascertain the quality and proportion of the amino acids which it gives and to see whether there are differences between the state of rest and that of activity.

When one examines, in the light of the teachings of histology, what milk secretion is, one sees that the mammary tissue itself plays a part in forming that secretion. We know that the cell develops; that it increases in size; that at a certain moment it breaks in order to pour its contents into the opening of the mammary sinus. This content is composed of crystalloids, but also of colloids, which previously formed an integral part of the tissue of the cell.

Chemical study of the mammary gland is not sufficient; we must also study the ferments contained. I have tried for a long time to discover an enzyme which I thought took part in the formation of lactose. My research has led me to no conclusion but I believe that this was due to a fault in technique. It would be interesting to repeat the experiment, with a change in the experimental conditions, which have for their object the separating of the enzyme from the tissue.

Finally, many problems are raised by the study of the milk itself.

In a series of papers which have been published this year in the scientific magazine entitled "*Le Lait*" (milk), I have endeavored to show what may be called the constitution of that liquid. As for myself, I believe that I now understand it. I think I know where its different constituents are to be found, and their interrelations. The study of this mixture, both crystalloid and colloid, which we call milk, is made clearer, so that when we find something abnormal in the composition of milk we can estimate its significance in a discriminating manner.

Research work that I am now pursuing allows me to advance the belief that the coagulation of milk under the influence of rennet ought to be investigated anew. In fact, it is not the caseinate of lime which coagulates under the influence of the rennet, but essentially the phosphate of lime. It is a mineral compound which plays the main part, and not that organic compound on which attention has been focused up to this time.

The study of viscosity, a factor of very great importance especially in the evaporated milk industry, will find, I hope, new light in my recent research.

Chairman JEFFERS. We will have a few minutes for discussion if anyone would like to discuss the paper.

The next paper is "Some aspects of the physiology of the mammary glands," by Dr. H. Isaachsen, professor of animal nutrition at the Royal Agricultural College of Norway. [Applause.]

Doctor ISAACHSEN. Mr. Chairman, ladies, and gentlemen: I ask you not to listen to my English, but only to the few words I have to say.

SOME ASPECTS OF THE PHYSIOLOGY OF THE MAMMARY GLANDS.

HAAKON ISAACHSEN, D. Sc., Norwegian Agricultural College, Aas, Norway.

Some years ago, in cooperation with my assistants, I undertook a number of investigations of certain questions connected with the functions of the mammary gland, and Herr Lalim (at that time assistant, now state adviser) and Herr I. Grande (fellow) made investigations of milking twice and thrice daily, and also of Hegelund's method of milking. The primary objects of the work were: The effect of more or less intense treatment of the udder during milking, the daily fluctuations in the composition of the milk, and the special factors in the separation of the milk fat. In addition to this, we classified certain results of the determination of the quantity of milk and the content of fat during the rutting season of the animals under investigation.

The effect of rutting (heat).—In the case of some animals the milk was weighed daily and the fat determined, results being obtained by comparing the figures for the rutting season, the five preceding and the five succeeding days (Lalim). In other cases (animals in experimental groups for other purposes) the milk was weighed daily, but the content of fat was determined in samples collected during five days, which of course gave less definite results, but which, on the whole, agree with the results of the first series. The quantity of milk was unchanged, increased, or decreased. In most cases the percentage of fat increased. No connection was to be found between the increasing quantity of fat and the decreasing quantity of milk. In some cases the animals reacted differently in the immediately succeeding periods—some animals were observed for two to three periods. Any possible depressing effect can be counteracted by careful milking during the rutting days. All the animals investigated were taken to a bull, and the effect of the entire period of rutting without covering was not determined.

Length of time between milking.—It is a common opinion that by milking twice daily the quantity of milk per milking is greater, and the content of fat is less than at the previous milking, when the interval from the previous milking is longer than that to the next milking, and vice versa. As there is usually a somewhat shorter interval between morning and evening milking than from the latter

to the next morning milking, evening milk is usually richer in fat than morning milk. In tests from 9 cows for five days we found the following conditions: Five mornings and 5 evenings, the content of fat was greatest in the evening; five mornings and seven evenings, the content of fat was greatest in the morning; difference of up to 0.5 in the percentage figures; six mornings and six evenings with practically equal content of fat, inappreciably richer in the evening; six mornings and seven evenings, somewhat irregular, most often very slightly richer in the morning.

It is possible that it can not be denied that the length of time between the milkings plays some part, but this factor is of subordinate importance. Thus, even in tests from milking thrice daily, the content of fat of the milk in the middle of the day was always above that of the morning and evening, irrespective of whether there were equal or unequal lengths of time between the noon milking and the other two milkings. The most important reason for this phenomenon is that there is a periodicity in the secretion of milk in the course of 24 hours. I shall return to this point later on.

Fluctuations in the content of fat of the milk from day to day or from period to period.—As is well known, the content of fat varies from day to day. The degree is inter alia dependent upon the individual. These variations may be "chance"; i. e., they may go in opposite directions with two animals day after day. But they may also be strikingly regular in the case of a considerable number of animals. On several occasions, in the course of our usual group experiments for the determination of the replacement values for feeding stuffs, in which each animal was given daily the various feeding stuffs weighed out in equal quantities during a period of research of 8 five-day periods, we have seen the content of fat in the milk from period to period regularly increase or decrease slightly for all animals. In other words, internal or external causes, the nature of which has escaped our observations, have had a quite uniform effect upon secretion.

Stimulation of the functions of the gland by manipulation.—It has generally been assumed that by milking thrice or more often daily, or by massage of the udder (Hegelund's milking method) it is possible to stimulate the glands to "over activity." In experiments here (Lalim and I. Grande), animals milking 10 to 15 liters of milk per day gave 0.8 liter more milk in thrice daily milking than in twice daily. Animals with 4 to 6 liters did not react with thrice daily milking. The content of fat of the milk was unaffected. The experimental laboratory at the Agricultural High School of Copenhagen arrived at the same result, with a very considerable number of animals. By comparing Hegelund's method of milking with an ordinary, good method, we found (Grande) no effects upon the quantity of milk by Hegelund's method, and in any case only a very immaterial increase in the content of fat. The experimental laboratory at the Agricultural High School of Copenhagen perhaps obtained a trifle more milk by Hegelund's method, but the content of fat was unchanged. Most of the other experiments mentioned in literature that have given fluctuating results were per-

haps not carried out with unimpeachable methods. If this kind of investigation is to be quite exact, it must be made through an entire period of lactation; but then the irregularities occurring in the milk production of the animals will always have a disturbing effect.

In my opinion, it has not been proved that there is any "stimulation" of the activities of the lacteal gland by "Hegelund's method," a kind of massage of the udder. It is possible that the increase in the quantity of milk in the case of the more copiously producing animals with thrice daily milking may be interpreted as an expression of stimulation. The question is here wrongly placed. The case is rather that secretion does not reach its full strength (in heavy milking animals) by milking merely twice daily, because inter alia the pressure in the cistern presumably becomes too great, the gland is physiologically "set" at more frequent emptying. I shall return to this matter when discussing the effect upon the composition of the milk by the calf's sucking.

The course of the fat curve during sucking.—In some of the literature dealing with this subject we find the doctrine put forward that during sucking the calf receives the richest part of the milk, and leaves the poorest part behind, or it is maintained that there is less difference between the content of fat in the milk at the beginning and conclusion of sucking than in milking—the milk drawn after sucking should be poorer in fat than the corresponding portion with milking exclusively, as maintained inter alia by Hittcher. His views on the matter are supported by Ostertag and Zuntz¹; who believed that they had proved that the milk sucked by their suckling pigs differed widely in its composition from that obtained by milking; the milk sucked was about twice as rich in fat and ash. Their method, however, can not be regarded as tenable. Hittcher's views are contested by Henkel. After concluding our work a report was received from Wellmann² (Budapest) who had collected the sucked milk from a calf by means of a tube in the gullet. The content of fat in the milk sucked by the calf varied within considerable limits, and increased from the first to the last portion collected. No comparison was made between the milk sucked and that afterwards milked. One calf was allowed in the morning and evening to suck a cow giving 8 liters of milk at each milking, after a "normal curve" for the content of fat in 4 to 8 portions of milk at each milking had been obtained for seven days. The calf was allowed to suck one-half to two-thirds of the milk each time, this being determined by placing the calf on the decimal scale whilst sucking. The fat curve for the portions obtained by milking after sucking remained quite the same as those of the complete milking of the previous days. The curve commenced almost exactly at the same place as that for the same portion during the milking tests. To be sure this test tells us nothing beyond the fact that the fat content of the milk after sucking was "normal," but as compared with Wellmann's result our discovery gives no basis for the above-mentioned theory.

¹ Landwirtsch. Jahrbücher, Bd., 37, p. 201, 1908.

² Milchwirtsch. Zentralbl., Bd. 7, p. 304, 1911.

Cause of the unequal percentage of fat in the milk at morning, noon, and evening.—I mentioned above that the length of time between two milkings is presumably of immaterial importance as a reason for this phenomenon. We should be inclined beforehand to believe that there is a periodicity in the functions of the gland in the course of 24 hours. It was, therefore, only natural that we should further investigate this point, and determine the difference between the composition of the milk which is found already formed in the cistern and which can be removed by the milking tube, and that which must be milked and which, in fact, may be formed at the moment of milking. The results of these determinations, which had also another object, are reproduced below. I will merely observe here that there appears to be a periodicity in the functions, so that, in particular, the fat content of the milk fluctuates from hour to hour during the day, and that, therefore, the question of the relationship between the fat content in the evening and morning milk is one connected with the time of milking, a time which appears to vary somewhat with the individual.

The function of the lacteal gland during the pause between two milkings and during milking.—In a number of cows the milk was removed twice or more often daily by drawing off the contents of the cistern in two portions by means of the milk catheter, whereupon we milked the animals dry in three portions. In all our animals the content of fat in the drawn, ready-formed milk was between 1 and 3 per cent, while that of the subsequently milked tests was considerably greater and increased greatly during milking (up to 13 per cent). I will give a characteristic instance: Drawn off, first portion, 533 grams milk with 1.9 per cent of fat; second portion, 2,292 grams milk, with 2.2 per cent fat. Milked, first portion, 356 grams milk, with 8.45 per cent fat; second portion, 241 grams, with 9.95 per cent fat; third portion, 102 grams, with 12 per cent; in all, 3,524 grams milk, with 3.6 per cent fat. The objection may possibly be made to the figures for the content of fat in the 700 grams of milk obtained by milking, that the milk may have been formed during the pause between that and the previous milking (morning), so that the table need not illustrate any difference in principle between the production of fat during the pause and during milking. This objection is untenable, for we obtained exactly the same results in the case of animals giving 5 to 6 kilos of milk at one milking, and no udder contains so much. In our animals the maximum capacity is about 3.5 kilos or a little more, and 2 to 2.5 kilos must be formed in these animals at the moment of milking. In order to clear up the matter still further, we proceeded to draw off the milk, in some cases by means of milk catheters with 1 to 2 hours' interval in the course of 12 or 24 hours, and then finally obtain the rest by milking; in other cases by continuous drawing off during the 24 hours by means of a catheter fastened to the udder by finger teats and with

exit into a rubber bag which was emptied every hour, after each milking.³ I will give one or two characteristic examples:

TABLE 1.—*Catheterized every other hour during the day.*

Portion.	Hour.	Milk.	Fat.	Quantity of fat.
		<i>Grams.</i>	<i>Per cent.</i>	<i>Grams.</i>
1	6 a. m.	2,510	1.85	46.44
2	8 a. m.	547	2.75	15.04
3	10 a. m.	1,037	4.13	42.83
4	12 midday	445	5.10	22.70
5	2 p. m.	245	4.63	11.34
6	4 p. m.	1,060	2.80	29.68
7	6 p. m.	170	3.50	5.95
8	6 p. m. (milked):			
	First portion	872	7.78	67.84
9	Second portion	255	9.55	24.35
	Total, portions 1 to 7	6,014		173.98
	Mean		2.89	
	Total, portions 8 and 9	1,127		92.19
	Mean		8.18	
	Total, portions 1 to 9	7,141		266.17
	Mean		3.73	

TABLE 2.—*Continuous removal of milk throughout 24 hours.*

Portion.	Hour. ¹	Milk.	Fat.	Quantity of fat.
		<i>Grams.</i>	<i>Per cent.</i>	<i>Grams.</i>
1	11 p. m.	108	4.25	4.59
2	12 midnight	76	3.18	2.42
3	1 a. m.	59	2.95	1.74
4	2 a. m.	56	2.85	1.60
5	3 a. m.	114	3.13	3.57
6	4 a. m.	213	2.55	6.20
7	5 a. m.	183	2.68	4.90
8	6 a. m.	300	2.65	7.95
9	7 a. m.	285	2.30	6.56
10	8 a. m.	94	1.20	1.13
11	9 a. m.	66	1.30	0.86
12	10 a. m.	177	1.55	2.74
13	11 a. m.	365	2.05	5.43
14	12 midday	244	3.70	9.03
15	1 p. m.	74	3.60	2.66
16	2 p. m.	160	3.95	6.32
17	3 p. m.	459	2.80	12.85
18	4 p. m.	210	2.50	5.25
19	5 p. m.	167	1.85	3.09
20	6 p. m.	145	1.75	2.54
21	7 p. m.	162	1.65	2.67
22	8 p. m.	112	2.10	2.35
23	9 p. m.	325	3.05	9.91
24	10 p. m.	110	3.70	4.07
25	11 p. m.	131	4.90	6.42
	Total	4,425		116.85
	Mean			
26	12 midnight (milked)	4,220	8.20	344.40

¹ The hours give the times of emptying the bag; it was attached at 10 p. m.

I have the results of removal, every other hour, from 5 cows, and of continuous removal from a total of 2 cows and 2 goats; in the main, the results are uniform for all animals. In the cases reported above we find an essential difference between the secretion in the pauses between milking and during the milking itself (case 1, draw-

³ I began to carry out these investigations without knowing of Professor Møllgaard's (Copenhagen) work on the same problem with goats.

ing off with successive milking), and in the secretion during periodic or continuous drawing off and under the influence of manipulation (cases 2 and 3). In case 1, there were first drawn off during one milking by means of a catheter 2,825 grams of milk, with 2.14 per cent (60.55 grams) of fat, with a very slight increase in the content of fat, after which 699 grams of milk were obtained by milking with 9.48 per cent (66.3 grams) of fat and with a great increase in the content of fat. In case 2, the amount of milk obtained by milking (portions 8 and 9) was about one-sixth of the milk drawn off by catheter in the course of the day, whilst the percentage of fat in the first-mentioned portions is about three times as great, and the amount of fat more than one-half of the corresponding amount in the last-mentioned portions. In case 3, after 24 hours continuous drawing off, 1 hour after the last removal there was obtained by milking about the same quantity of milk as that during drawing off by means of the catheter, but the percentage of fat in the first portion was more than three times as great as in the last instance, and the quantity of fat about three times as large. Thus in some way or another the mechanical (nervous? chemical?) influence upon the gland has had a powerfully stimulating influence upon secretion. Stimulation also makes itself apparent by the well-known steady increase in the content of fat in the milk during milking. I shall return to this matter latter on.

But cases 2 and 3 show something else: There is a definite periodicity in secretion in the course of 24 hours, with a somewhat irregular increase and decrease in the intensity of secretion from hour to hour. In case 2 (drawing off every other hour during 12 hours), the minimum percentage of fat is at the drawing off at 6 a. m. (this result, however, is not significant, as after about 11 hours rest the glands were almost full of milk, in which circumstances the content of fat is always small), its maximum by drawing off at 12 noon, after which there is again a fall until 4 p. m. and a slight rise until the last drawing off at 6 p. m. The minimum quantity of fat is found at 6 p. m. on account of the small amount of milk, and the maximum at 10 a. m., if we disregard the uncharacteristic first portion at 6 a. m. In case 3 (continuous drawing off for 24 hours), we see that the amounts of both milk and fat and the percentage of fat fluctuate up and down considerably, with a minimum percentage of fat at 8 a. m. and maximum at 11 p. m. and then at 2 p. m. The maximum amount of fat is found at 3 p. m. on account of the maximum quantity of milk at that time.

Finally, I would emphasize that these investigations, like many others, have shown that an increasing percentage of fat often coincides with an increasing quantity of milk, and vice versa.

In the periodicity which thus appears to prevail during lacteal secretion, and which presumably is related to varying intensity in metabolism, I find the essential cause of the factor discussed above, viz, that in practice there is so often a difference between the fat content of the milk in the morning and evening with twice milking; in the first instance it is the time of day which is a condition for the content of fat of the portion of milk.

Variations in the content of dry matter in the milk and its composition during milking.—So far as I can see we are still rather

ignorant as to the cause of the rise in the content of fat in the milk during milking. In order to obtain a basis for our consideration of the investigations in this domain reported here, I determined in the case of a considerable number of animals the normal curve of the increase in the contents of fat by milking out, in portions of 500 cubic centimeters each, the first 100 cubic centimeters of which were analyzed. The last milking was sometimes only 100 to 50 cubic centimeters. The first 100 cubic centimeters had not rarely a bare 1 per cent, or even as low as 0.5 per cent of fat, and the content seldom exceeds 1.5 per cent.

In the majority of cases the curve for the content of fat exhibits in the various fractions a rather feebly rising course for at least two-thirds of the milk, whilst it then rises steeply and in some cases to a great height, 13 per cent to about 14 per cent. In certain animals the rise is comparatively insignificant, 1.5 to 2 per cent. The phenomenon, however, that the rise regularly attains impetus toward the conclusion of milking gives us a plain hint that there exists the above-mentioned essential difference between the functions of the gland during the pauses and during milking.

I reproduce below, in condensed form, an instance of a characteristic course of secretion in the case of a cow with about 5 liters of milk one morning, where the first 100 cubic centimeters of each 500 cubic centimeter portion was analyzed; the last, the tenth portion, was about 100 cubic centimeters in all.

Portion.	Dry matter.	Fat-free dry matter.	Fat.	Albumen.	Sugar.	Ash.
1.....	10.10	9.12	0.98	3.26	5.26	0.602
10.....	19.05	7.75	11.30	2.96	4.25	.539

The content of the fat-free dry matter here falls during milking; it is quite a common, although not entirely constant, phenomenon; there are certain cases of unchanged, or even of an immaterial rise in the content, but a decrease in the content of sugar is usual. In this animal the reduction in fat-free dry matter is due to a fall of 0.3 in the percentage of albumen, and 1 in the content of sugar percentage.

The explanation of the increase in the content of fat, which has longest held sway, is the well-known, we may well say naive, explanation, that the fat is deposited in the form of cream in the gland passages and there clings fast to the walls, so that it is only removed by steady and continued manipulation. This view, although possibly not definitely disproved, is, however, made quite improbable by means of a demonstration of the greatly increasing content of fat in the milk which is milked immediately after 24 hours continuous outflow of milk; in this case the cream could not be deposited on the lacteal passages, as these were steadily emptied. The same increase is also obtained if before milking we place a goat on her back, and then carefully massage the glands, in order to abolish the effect of any possible deposit of cream in the gland passages.

If the theory is correct as to the deposition of cream as a cause of the phenomenon here discussed, we might expect to get the fat saved

up in the gland passages by incomplete milking at the next milking; if we do not then wish to construct a hypothesis to the effect that this fat is resorbed by the gland epithelium during the period of rest, a hypothesis which is not attractive. I therefore first caused 12 heavy and lighter milking cows to be milked out in portions for some days, and determined the course of the fat curve in the portions, and then tried one or more days of incomplete milking in the case of a number of animals, leaving in some about one-half to three-fourths liter, and in others as much as 2 liters. We have a very large number of figures which show that in the case of the animals in which only a small quantity of milk was saved, there was nothing in the course of the fat curve during the next day's complete milking to indicate any regain of the "saved up" fat from the previous day's incomplete milking, neither in the first nor in the subsequent portions of milk. If a comparatively large quantity of milk was saved at the incomplete milking, the percentage of fat in the first portion's incomplete milking was somewhat higher than after complete milking. In all cases the total content of fat of all the milk in incomplete milking, we may say as a rule, was lower than in complete milking. In the first-named series of tests there is thus no sign of "regaining" "saved up" fat; in the latter, however, where the quite large quantity presumably caused some disturbance in the physiology of the gland, and when a "regain" apparently took place, as far as I can understand, the higher content of fat in the first fractions at subsequent complete milking was due to the special phenomenon of fat secretion to which I shall refer below.

I consider that these results, in conjunction with the arguments put forward in the foregoing passage (the difference between the percentage of fat in the milk drawn off per catheter and the milk drawn thereafter) give decisive evidence against the common doctrine of "cream deposits," and supply, if such be necessary, the proof of the experience known to every competent, practical man, viz, that inferior, incomplete milking occasions loss of milk and especially of fat.

Cause of the increase in the content of fat in the milk during milking.—We might be inclined to seek the reason for the said phenomenon, at least partly, in the pressure of the milk in the gland passages and alveoles during the pause between two milkings, that the back pressure, if the expression may be used, exercises an enfeebling influence upon the secretion of organic matter or, in this case, of fat. In our measurements the pressure of milk immediately before milking in twice daily milking of animals giving 5 to 6 liters of milk per day, was about 20 centimeters, in certain cases somewhat lower, measured from the lower edge of the udder, i. e., 5 to 0 centimeters measuring from the uppermost edge—alveoles—of the udder (the distance from the lower to the uppermost edge of the udder in our animals was 15 to 18 to 20 centimeters, in animals giving 12 to 15 liters of milk daily at least 40 to 50 centimeters, 20 to 30 to 35 centimeters from the upper edge. Even though it can not definitely be denied, that this pressure in the gland may have something to do with the problem, I have not succeeded in proving that there is any connection of importance. In the catheterizing tests as described above the pressure in the cisterns before drawing

off the milk portions did not exceed 8 to 9 centimeters from the lower edge of the udder, and yet the content of fat of the portions drawn off rose from 1.75 per cent to more than 5 per cent, after which the portions milked in the evening rose to about 10 per cent. During the continuous removal of milk throughout 24 hours (see above)—without pressure in the cisterns—the content of fat of these portions also rose from about 1 per cent to nearly 5 per cent, whilst the portions then obtained by milking had as much as about 8.25 per cent with increasing content.

In order more closely to follow the course of the secretion of fat in unequal stages of gland activity, we took two series of gland tests, from cows which before taking the test had not been milked or had been tapped by means of the catheter, or half milked or completely milked. One of the series was taken from animals immediately after slaughtering, the other by harpooning from the living animal under local anesthesia. The portions of gland were preserved in 10 per cent formol, a section was frozen, colored with hæmatoxylin and soudan, and the microscopic work was done under the guidance of Professor Tuff, histologist at the agricultural college, Aas.

The microscopic picture was characteristic in all the specimens prepared. Glands which had not been milked, or were only tapped before taking the sample, had large dilated alveoles and narrow bands of interalveolic connective tissue. The epithelial cells were quite full of drops of fat. In preparations taken from completely milked glands, the alveoles were considerably smaller, the bands of connective tissue were broader, and the epithelium quite free from drops of fat. The appearance of the glands which had been half milked or more was in the main similar to that of glands not milked, but the content of drops of fat was perhaps a little less.

From the above it should be possible to construct the following hypothetical picture of milk secretion: In the pause between two milkings, the gland epithelium is filled to overflowing with drops of fat. Under the formation of milk in this pause, the fat is secreted with greater difficulty than the other constituent solids. It appears that the factors which regulate the secretion of milk during this phase (the chemical regulation?) are not of such a kind that they determine the full activities of the gland. The same is mainly the case so long as the ready-formed milk in the cisterns and lacteal channels is milked out, at this phase the milk retains the same low percentage of fat or it increases comparatively little, the gland cells, therefore, still have a considerable content of drops of fat. By degrees the regulating factors act more strongly, and presumably other regulating factors appear (nervous, mechanical, thermal?). During this the fat is removed more and more completely, the formation of fat in the cells no longer keeps pace with the removal of fat, and finally the cells become free from fat, the content of fat in the milk at the same time reaching its maximum.

A support of such a theory of a regular periodicity may presumably be found in the circumstance that the quantity of leucocytes (epithelium cells?) in the milk also increases during milking (Olav Skar, Christiania).

Mention has been made of regulating (or stimulating) factors. As is known, our knowledge of the nature of these impulses is small.

Physiologists appear more and more to abandon the terms "nervous" or "mechanical" stimulus and to agree to the hypothesis of a "chemical" (hormone) stimulation. In my opinion our present knowledge of the course of lacteal secretion may lead to a hypothesis of a multiple stimulus, inter alia, a hypothesis of a special irritation during milking by manipulation or by sucking. That the so-called mechanical stimulus during manipulation is not merely of a mechanical nature, seems to me to appear from the phenomenon, which is known also amongst practical men, viz, that the milking machine does not succeed in removing the last remainder of the milk, even if the machine is allowed to work for a much longer time than that needed for milking by hand, and that irrespective of the fact that the machine is more energetic than the hand in its mechanical activities. We do not know whether this circumstance could be altered by allowing the machine to work for a longer time than usual through weeks or months—i. e., whether it is possible to "accustom" the gland, get it "timed," to the special kind of excitation of the machine—as in practice it is undesirable to allow the apparatus to remain on so long a time. Neither we nor others have been able to prove that the calf by its sucking brings about any specific excitation of the gland function, an idea which is current among some practical men.

Chairman JEFFERS. Is Doctor Koestler present? He has a paper here, but as he is not here I think we had better defer that, and some one may read the abstract later.

Dr. H. M. Evans, professor of anatomy, University of California, is to give a paper, "On the existence of a hitherto unknown dietary factor essential for reproduction." [Applause.]

ON THE EXISTENCE OF A HITHERTO UNKNOWN DIETARY FACTOR ESSENTIAL FOR REPRODUCTION.¹

HERBERT M. EVANS, M. D., professor of anatomy, University of California, Berkeley, Calif.

If female rats are reared upon the now well-known "synthetic" nutritive régime consisting of fat, carbohydrate, and protein in relatively pure, separate form to which are added an appropriate salt mixture and daily doses of the vitamins A and B, normal growth and every appearance of health results. The animals are of splendid size, sleek coated, and active. Depending somewhat upon the season of the year, either a large proportion or, indeed, practically all of such animals are sterile. We have employed a basic ration of casein (18), cornstarch (54), and lard (15), following Osborne and Mendel, to which milk fat (9) and salts² (4) are added, the animals receiving

¹ Aided by grants from the Bache fund of the National Academy of Sciences, the committee on research on sex problems of the National Research Council, the Dairy Division of the United States Department of Agriculture, and the State Dairy Council of California.

² The salt mixture adopted was that which has been frequently employed by E. V. McCollum and which consists of—

NaCl	173
MgSO ₄ (anhyd)	266
NaH ₂ PO ₄ + H ₂ O	347
K ₂ HPO ₄	954
CaH ₄ (PO ₄) ₂ + H ₂ O	540
Fe citrate	118
Ca lactate	1,300

separately and daily 0.4 to 0.5 gram dried whole yeast (Harris). *The sterility produced is a dietary deficiency disease and can be quickly cured by a change of dietary régime.* It yields a highly characteristic picture, the chief features of which are the occurrence of apparently normal œstrus and ovulation and the fertilization and implantation of the developing ova, but invariable disease and resorption of the products of conception.

It at first occurred to us as possible that we had discovered in the rat a need for the antiscorbutic vitamin C, which was not evidenced in any other way in this animal. In order to test the point, the basic dietary régime was supported by the daily administration of orange juice in one series of experiments and by lettuce leaves in another series. Only one gestation out of five or six was successful with the orange juice régime, but every individual tested produced litters of healthy young when fresh green lettuce leaves had been added to the dietary. It thus seemed apparent that we were in the presence of a new member of the "vitamin" substances, or specific dietary needs, which we have provisionally designated by the letter X, or as the antisterility factor, and we have attempted to chart its occurrence in natural foodstuffs by the simple tests of whether or not they would alleviate or fail to alleviate the dietary sterility disease. Several hundred gestations have been conducted in the following manner. Litter-mate sisters have been reared upon the above so-called synthetic or pure dietary régime and every individual permitted to have a first, or trial, gestation. In this manner it was possible to use animals in which in the case of every individual the occurrence of sterility had been proven. At this juncture, and only at this juncture, in some of the cases a single natural foodstuff was added to the diet and the fate of further trial gestations now ascertained. The remaining cases were retained as controls, maintained merely on the original ration. Their sterility has continued unabated.

When animals of the opposite sex are paired and some weeks allowed to elapse without offspring being produced, while sterility is highly probable, it is nevertheless proper to regard it as only presumptive. It appears possible, however, to establish it beyond peradventure by proper attention to the various steps in the physiology of reproduction. We have taken the precaution to mate females whose fertility it was sought to investigate only with males of known fertility and at the incidence of the appropriate time in the œstrous cycle as determined by daily examination of the vaginal smear. Control experiments with normal females have taught us that somewhat over 80 per cent of animals handled in this way will accept coition and will deliver litters of healthy young at the conclusion of 22 days of gestation. Furthermore, in all cases we have known the complete sexual history of our animals, i. e., the time of occurrence of the first and of all subsequent ovulations; inseminations were carried out at the first œstrus beyond the sixtieth day of age. In all instances the occurrence of sexual congress has been confirmed by the detection of the plug (bouchon vaginale) and by the microscopic detection of residual sperm in the vaginal canal. A further check upon the fate of an insemination is afforded by our use of the "placental sign"; i. e., the appearance of erythrocytes

in the vaginal smear from the fourteenth to the seventeenth day of gestation. This phenomenon occurs in all normal gestations and is probably indicative of placental leak; at any rate it heralds the existence of placentation (Long and Evans). We never miss it in cases where implantation has occurred, nor is it found when the ova (whether fertilized or not) fail of implantation. By its detection one may satisfy himself that all of the early steps in the trial gestation have been accomplished (insemination, ovulation, fertilization, migration, and implantation of the ova).

It is remarkable that all these events take place in females with the specific dietary sterility disease, but that the expected young are never born. Autopsies performed late in gestation show various stages in the resorption of the young. A normal proportion of eggs have been fertilized and implanted (at least two-thirds of those liberated per ovulation), as determined by comparing the number of corpora lutea of gestation in each ovary with the corresponding number of implantation sites in each uterine horn. Some of the implantations have apparently begun to resorb shortly after their establishment. In them no trace of the embryo persists; whereas in other cases macerated embryos or, indeed, large foetuses may be found; rarely, a single foetus is found still living. Studies of the uterine mucosa just before implantation (i. e., late in the fifth day after coition or early in the sixth day) show that the "implantation bed" is abnormal, for quite a massive extravasation of erythrocytes has occurred, presumably by diapedesis, infiltrating the connective tissue meshes of the endometrium. When placentaë are established, these exhibit a similar type of abnormality, for there are hæmorrhages in them and other circulatory faults, chief of which is the occurrence of characteristic greatly distended maternal venous sinusoids. It might thus appear that the dietary sterility disease is occasioned solely by faulty implantation and specifically by the placenta's need of some dietary constituent for endothelial strength. It is not so clear, however, that the deficiency disease attains its effects solely by impairment of placental structure and function.

Disease of the ova, and hence of the embryos, may be fundamental and not secondary. The conception that the ova are at first normal was indeed somewhat strengthened by our accidental finding that in some cases foods which cured the disorder were administered after ovulation had taken place and hence affected the developing young, chiefly, if not entirely, after the uterine attachment had been made. Yet the unequal progress of the disease in two neighboring blastoderms, adfixed in the uterine wall but a few millimeters apart, is hard to explain except on the basis of unequal resistance to destruction on the part of embryonic tissue masses. One must also, of course, think of the hypothesis of primary disease in the ova themselves. Our recent discovery that the spermatozoa are injured and, in fact, eventually destroyed by the basic dietary régime lends support to the possibility that the germ cells themselves always possess a fundamental need for the new dietary constituent.

In attempting to discover the cause of inadequacy in our "pure" or basic ration, we have given some attention to the protein moiety. A higher protein content in the form of more casein does not relieve

the situation, nor have any changes which we have made in the quality of the protein resulted in cures. Thus yeast protein has been added to the casein and lactalbumen has been substituted for casein without avail. Furthermore, belief that the limiting factor in casein inadequacy would lie in its low cystine content led us to add this amino acid to the casein without avail.

Since it seems hardly likely that the chief caloric constituents of the diet (lard and cornstarch) could be at fault, we next investigated the possibility of inadequacy in the vitamins A and B, an inadequacy conceivably shown up only by the unusual demands of reproduction. The statement has already been made that when yeast was added in such quantity as to yield additional support to the protein, cures of the sterility did not result. Thus a fourth by weight of the entire ration has been constituted by whole dried yeast with consequent enormous excess of the vitamin B. When the butter quota was greatly increased (i. e., so as to constitute 25 per cent by weight of the diet), it is true that some cures of the sterility resulted, and when animals are reared in this way they may be normally fertile. We believe this is due to the possession by milk fat of a definite, though low, quota of the new dietary substance. Our reasoning here is as follows: Crude Norwegian cod-liver oil was obtained by us and compared with our own milk fat for its content of the vitamin A. Our tests showed it to contain at least eleven times as much of the vitamin A as did the butter. When the milk-fat quota of our diet was replaced by this cod-liver oil the animals (which not only showed no signs of deficiency in vitamin A but which we must furthermore assume to have possessed a great excess of this factor) were nevertheless sterile. And the sterility disease has continued unabated when in some cases we happened to employ for a limited time 25 per cent by weight of the cod-liver oil. The experiments with this substance would also appear to enable us to segregate the new factor from the vitamin present in cod-liver oil which is responsible for the cure or prevention of rickets, and which has been designated tentatively by McCollum as vitamin D.

The efficacy of fresh green lettuce leaves in curing the dietary sterility is always very striking. To the animals it perhaps constitutes an especially attractive relief from the basic diet, for one has no difficulty in getting them to consume large quantities of it. The curative dose most frequently employed by us has been 40 grams of the fresh substance, an amount corresponding to somewhat less than a gram and a half by dry weight. In the colony, it has become a routine method of restoring fertility and of thus furnishing what we always regard as the necessary proof of the normality of an animal when various other attempted dietary cures have failed. To date, 53 trial gestations have been studied with this as a curative substance, and 50 of them have resulted in the birth of normal litters of young. Two tests have indicated that as little as 10 grams of the fresh leaf substance may result in the birth of healthy young. We have further ascertained that the seedlings of the Canadian field pea similarly restore fertility. It is too early to report upon the quantitative tests which will determine whether or not any loss occurs in the content of the new vitamin when leaves are dried. Fertility

has usually resulted when we administered 1.5 grams of the powder made from lettuce leaves dried in an oven with fair air exchange and a temperature of 100° to 130° C. The powder obtained from milling dried alfalfa leaves is similarly effective.

While the experiments which have been reported above would seem sufficient to separate the new dietary factor from the water soluble vitamin C, or antiscorbutic substance, this separation is effected in a much more conclusive way by the fact that the whole cereals protect against sterility or cure it when it is once established. Thus whole wheat and oats are effective. From negative tests we are certain that white patent flour is ineffective, even when constituting one-third, by weight, of the total ration, whereas, careful work with wheat embryo has shown a remarkable potency of this substance. It is now possible to state that one-fourth gram daily (250 milligrams) of wheat embryo restores to normal fertility animals in each of which, as is usual in our routine, the sterility disease has been proven to exist.

One of the surprising results has been the demonstration of an almost total absence of the new vitamin from milk. Fresh milk has been faithfully administered with a pipette in 5 and 10 cubic centimeter doses without effect, and we next sought to recover some of the possible content of milk in the new factor by employing the total milk solids. When these were used, either as skim-milk powder or as whole-milk powder, so as to constitute as much as one-fourth or one-third by weight of the total ration, the sterility disease continued unabated in all but a small proportion of the cases.

The factor essential for normal reproduction may occur in a wide variety of foods. We have found it present in egg yolk by administering daily one-third of the fresh total yolk substance, and to our surprise it has been possible to demonstrate it in meat. The jaw and cheek musculature of the cow contains enough of it for daily doses of 1 gram of the cooked meat to be adequate.

We have also conducted several hundred experiments in which small amounts of single natural foodstuffs have been used as prophylactic rather than curative substances. The trial foodstuff was administered during the early lifetime of the animal, and as a rule a minimal period of 40 days has intervened between weaning, when the animal was put upon the prophylactic diet, and the inauguration of the first trial gestation. These experiments were conducted not merely to demonstrate the prophylactic or protective action of certain foods, but also in the hope that we might be able to show that the new food essential is stored by the body. It is conceivable, for instance, that foodstuffs which fail to contain enough of the substance X to immediately invoke fertility when fed during the 21 days of an actual gestation, could nevertheless contain appreciable amounts of the new substance, and, if the phenomenon of storage occurs, amounts large enough to ultimately enable reproduction to take place. We have shown that lettuce leaves, either fresh or dried, cheek muscle, the cereals, egg yolk, and beef liver all bestow a complete prophylaxis or protection. At the same time, some of the substances which are not completely satisfactory when administered during the short time involved in the curative experiments, are entirely so when used for a longer period of time for prophylaxis. This was the case, for

instance, with 25 per cent milk fat and in a few cases even with one-third by weight of milk powder. Now, although milk powder is thus always too low in its content of the new factor to act as a curative agent, yet when fed in this high proportion (one-third by weight) during the first 40 days after weaning, it may induce fertility. This is, for instance, always true of whole-milk powder. Even skim-milk powder may be efficacious when used in this way, and it can be shown to be higher in X when coming from cattle on fresh alfalfa than when from those on dry range, an observation perhaps devoid of interest from the standpoint of milk as a "fertility" food (since X is always low in it), but of great interest as showing that even this secretion carries it when the diet is very high in X.

The phenomenon of storage is best shown by the survival of fertility when animals have been transferred from a satisfactory ration to the basic, or "pure" diet. In these instances, depending upon the abundance of the factor X in the previous satisfactory diet, animals maintain their fertility for a greater or lesser time.

Finally, it has been possible to extract from curative foodstuffs with 80 or 95 per cent ethyl alcohol and with ether the curative principle. This is singularly concentrated in the deep brown oil thus obtained by ether from wheat embryo after preliminary treatment with hot 80 per cent alcohol. A daily dose of slightly more than 100 milligrams of this oil confers cures of the dietary sterility. The preliminary extract made with the alcohol is also potent, so that in nutrition experiments in which such an alcoholic extract of wheat germ is used as the sole source of vitamin B, the new vitamin has inadvertently been conveyed to animals in ample abundance for fertility to result. In most instances water extracts have been ineffective.

Although many experiments are in progress, we are as yet not ready to report fully upon the production and cure of dietary sterility in the male, but it is of interest to note that the disease occurs there and that in the case of the male we must look upon true germ cell injury as the undoubted effect of lack of the new dietary essential.

Chairman JEFFERS. Discussions of this talk are in order. Is there any discussion?

Capt. JOHN GOLDING (England). I would like to extend my congratulations to the committee for the splendid papers which they have secured at this and other meetings.

It is very difficult, indeed, to follow a paper which is so full of new material as the one we have just heard, and I hesitate, almost, to ask questions, for fear that it may already have been explained.

Personally, I have been working with Doctor Zilva, in England, on pigs. We have also used rats, and we have been bothered with this question of sterility. We have also gotten some very deformed litters on deficient diets, and our results will have to be reconsidered in the light of Doctor Evans's points.

One point I didn't quite understand: You said that the English workers fed too high a quantity of butterfat, yet at the same time their rations contained the factor X. It seems to me that it is difficult to make those two statements agree. I would like to ask about that. I am particularly interested in the results obtained with the

dried, separated milk obtained from cows fed on green pasture. They are quite in agreement with our results.

Chairman JEFFERS. Doctor Evans, will you answer the questions?

Doctor EVANS. May I state that I was misunderstood? Since we were positive, as we were until we were aware of this new factor, that any amount of milk fat up to the total fat quantity or quota of the synthetic fat ration was entirely proper, there certainly could have appeared no harm in putting, as Doctor Drummond did, 15 per cent of milk fat in the synthetic ration. Doctor Drummond and his co-workers have reported several generations of animals fed upon this ration. We were disturbed to find these workers securing fertility, until we embarked upon the study of milk fat of animals fed upon a known forage, and I believe the whole explanation of the richness even of skim-milk powder in some cases in the factor X lay in the fact that in these cases the cows from whose milk the powder was made had alfalfa pasture and that the fresh, green leaves of alfalfa are even more potent than any leaves which we have so far experimented with. I do not believe that the alfalfa plant is unique, but it is richer in the X factor than any other material which we have studied, and we also took the natural grasses, both of the coast near San Francisco and of our northern counties, as a check.

Chairman JEFFERS. Are there any other questions?

Dr. E. B. MEIGS (physiologist, United States Department of Agriculture). I would like to ask Doctor Evans about the relative quantity of this factor X in grasses and in such leguminous plants as alfalfa and clover. I feel a little like Captain Golding, that he has given us so much that we want to take that we have a slight indigestion. He may have covered this point in the lecture, but if he did I didn't get it.

Doctor EVANS. I am quite incapable of answering this question of really major importance which Doctor Meigs has presented. I state this, though, in repetition of my last sentence, that we have investigated the milk fat from cows pastured during the months of March and April on the grasses present on the Berkeley Hills University Dairy, which run from sea level to an elevation of 1,800 feet. I can not give you a report on the species of grass; but that milk fat is surprisingly lacking, even though it be from cows on green forage, in the factor X. In about a fourth of the cases 24 per cent of it confers fertility, but 15 per cent of it never does. In the case of cattle held knee deep in fresh alfalfa, less than 15 per cent gives the effect which we secured with 25.

The field, of course, for quantitative work is open here, but we are so impressed with the necessity of attempting to do further work with actual isolation from a few food materials known to be surprisingly high (in our instance, wheat germ), that I believe it will be advantageous for us, at any rate temporarily, to leave this question in order to be able to do something with the chemistry of the X factor. [Applause.]

Mr. N. M. CREGOR (Ward Baking Co.). I would like to ask Doctor Evans if he has found X more closely associated with the vitamin A or with water-soluble vitamin B; and, furthermore, ask him if he has done any experimenting after extracting the wheat germ with ether, and whether he found X present in the wheat germ after it is extracted.

Doctor EVANS. We have fed the residues after extraction. None of our extractions have been what a chemist would call a good job. When the residues are fed in high doses they contain unmistakable amounts of X. When they are fed in anything like the original curative dose they fail. We have greatly reduced their X content.

Regarding the association in natural foods of the substance X with the substances A and B, I thought the charts I showed were perhaps enough to make it clear that, like A and B, this is present in some foods where all four, A, B, C, and X, occur. It is absent where A is notoriously high—in cod-liver oil; it is absent where B is perhaps highest—in certain types of dried forages.

Professor W. M. REGAN (California). I would like to ask Doctor Evans if he has any evidence as to the effect of this substance on the male organism?

Doctor EVANS. I had hoped to be able to bring here the first week in October the results of nine months' work, but our records are not complete. This disease affects the males and leads to, in this case, injury of the germ cells. We are not certain that injury of the germ cells occurs in the female for the simple fact that the early stages of development are not so greatly interfered with, but more important is the fact that one can save the situation after ovulation has happened. The curative food in the case of the female can be administered from one to three days after ovulation and still save the situation.

Chairman JEFFERS. We will go on with the next paper, by Dr. G. Koestler, chief, chemical division, Liebefeld Experiment Station, Bern, Switzerland. Doctor Koestler's paper deals with "Studies on milk secretion during the last part of the lactation period."

STUDIES ON THE MILK SECRETION DURING THE LAST PART OF THE LACTATION PERIOD.

G. KOESTLER, Ph. D., chief, chemical division, Swiss Dairy and Bacteriological Research Station, Liebefeld, Bern, Switzerland.

It is a well-known fact that toward the end of the lactation period the milk begins to have a salty taste and a corresponding change in the composition. By special studies, we have found that this appearance is not the consequence of the normal secretion of milk. The quarters of the udder, respectively the glands, which are found to be infected by bacteria acquire during the last days of lactation a light degree of catarrhal inflammation. This latter is increased by the forceful stopping of the milk secretion, caused by omitting one, two, or three milkings. This method of finishing the period of lactation is necessary to carry the glands over in the resting period (dry period); in other words, to protect them against the influence of an immediate stopping of secretion. During this period of stopping (drying off) the secretion, we have better conditions for the increase of the bacterial content in the affected quarters of the udder. In these quarters we have during the last days of milking a more or less increase in the catarrhal inflammation; corresponding with the latter, the contents of the milk are changed in a very marked manner. This change of the milk contents, among others, is exceedingly characterized by an increase in the chlorine content and a decrease in the

percentage of sugar content. For this reason the ratio of the chlorine content divided by the sugar content ($\frac{\text{Chlorine content}}{\text{Sugar content}}$) is a good means of detecting this kind of milk. I know very well that this ratio or quotient can not be regarded as purely physiological, but this way of detecting the trouble is practical, and I am not convinced that other means of comparison illustrate as clearly the manner of change in milk here referred to.

The other quarters of the udder, which were not infected with bacteria during the period of lactation, will not be changed in the above manner; the milk keeps its normal contents till the end of the lactation; that is, the milk remains sweet.

During the period of rest (dry period) the udder secretion (milk) is changed in such a manner that more and more the character of colostrum is indicated; we have a change especially from the point of view of the albuminoid content. The albumen predominates in comparison with the other exceedingly soluble albuminoids (globulin, etc.). Quite apart from other changes (increases of mineral matter, so-called granular bodies, cells, etc.) during the rest period, the changes of the udder secretion are generally effected in the same manner as those which we can observe when, for some reason, the milk remains in the udder (when cows are not milked for a certain time, when milking in the usual manner is not possible, extreme sickness of the cows, etc.).

Accordingly, bacteriological studies of several authors, especially the recent work of W. Steck, show that the infected quarters of the udder generally lose the catarrhal inflammation during the resting period; bacteria-destroying substances from the blood lymph, etc., effect this change. This result finds a parallel in the chemical contents of the secretion, the latter having the same quality in all quarters of the gland. Only the secretion of those glands which were essentially inflamed during the last days of the milking period show their abnormal nature also by special properties of the secretion.

For dairy practice it will be worth knowing that the end of the lactation period (the last milking days before we leave the udder for the resting period) is the best time to inspect the udder, its quarters respectively, in respect to the normality of secretion. If the milk is markedly salty, the quarter of the udder is infected with bacteria (coccus, streptococcus, *Bacillus abortus*, etc.), and is therefore incapable of producing healthy milk. Cows from which two or more quarters of the udder give highly changed (salty) milk should not be kept longer for milk production; their milk then, from time to time, is not of desirable quality. It may also be said that a high milk production will not be a sure sign of normal secretion; on the contrary, we have found in several cases that cows which were forced to a specially high milk production were not quite sound in the udder.

Chairman JEFFERS. Is there any discussion of this paper?

The next paper is by Dr. E. B. Forbes, director, Institute of Animal Nutrition, Pennsylvania State College, on "Evidence of deficiency of mineral nutrients in the rations of milk cows."

EVIDENCE OF DEFICIENCY OF MINERAL NUTRIENTS IN THE RATIONS OF MILK COWS.

ERNEST BROWNING FORBES, Ph. D., director, Institute of Animal Nutrition,
Pennsylvania State College.

Throughout the writings of veterinarians in the standard reference works, there is recognition of the idea of deficiency of mineral nutrients, especially calcium, as a cause of disease in cattle.

In many countries associated with certain unusual conditions as to soil, climate, and feeding, there have appeared disorders in the health of cattle which have been attributed to deficiency of mineral nutrients. Such a situation was recognized in Norway as early as 1660, and the world around is a commonplace of veterinary knowledge.

The abnormal states of nutrition of cattle which especially involve the mineral components of the body are discussed under the names of rachitis, osteomalacia, osteoporosis, fragility of bones, osseous cachexia, malnutrition of the bones, halisterisis of the bones, and colloquial designations such as creeps, big head, licking disease, and lamziekte.

These diseases and states of malnutrition, however, are peculiarly ill-defined; and nothing is more clear than that their pathology is imperfectly understood. They have not been made the subject of critical studies in the light of our present knowledge of nutrition, and the relation of calcium deficiency to these disorders remains to be clarified.

Still, the belief prevails among veterinarians that calcium deficiency is one of the causes of the diseases of the bones of cattle; and a long series of agricultural investigations have clearly demonstrated the existence of simple malnutrition of the bones as determined, on the one hand, by poverty of the ration in calcium, due to kind of food, soil, climate, and drinking water; and on the other by the conditions of life of the animal, especially as to growth, reproductive activity, and lactation.

As for the details of these pathological conditions, I shall not begin the extended discussion which is required to explain a matter so imperfectly understood, but will refer anyone who is interested to Hutyra and Marek's *Special Pathology and Therapeutics of the Diseases of Domestic Animals*.

Let us now consider the ideas and observations of dairy-cattle breeders in the United States. To the scientific man common knowledge is accepted with reservation, because it is often shown to be fallacious by disagreement within itself, but it is so much more often right than wrong that it is only prudent, in seeking the truth on any subject, to inquire first, as to the practical understanding which has been reached by informal observation.

Among my correspondents are some who have fed bone meal to dairy cows, and who were unable to note any advantage from so doing. Obviously the possible benefit from the feeding of mineral supplements is determined by the conditions under which a herd is maintained. If the general situation is already ideal, it would, of course, be impossible to improve it by providing additional mineral nutrients.

I have noted, however, and so have others, that cows kept on dry feed, without access to pasture, develop a craving for mineral nutriment. The morbid appetite manifested, under such conditions, by the eating of dirt, gravel, sticks, leather, bones, etc., is restored to normal by the feeding of bone meal.

That the overtaxed milk cow is in a state of nutritive depletion is so clear as to require no proof; and that this depletion involves all essential nutrients, among them the minerals, is also obvious.

Evidence of such a reduced state of nutrition is seen: (1) In the unfavorable effects of forced feeding on fertility, and of forced feeding during one period of lactation upon the milk production during the succeeding period; (2) the increased difficulty in getting a cow with calf with advance in the period of lactation; (3) the dwarfing effect of early breeding; (4) the occasional failure of a cow, after calving, to approach her normal milk yield; and (5) the unfavorable effect, upon milk production, of a cow's calving while in especially thin condition, or without having had an adequate dry, resting period.

Successful dairymen of my acquaintance also believe that mineral deficiency of the ration may cause obscure lameness and enlarged joints, paralysis as calving time draws near, retention of the placenta, and delay in getting with calf. These experienced observers also report that the feeding of bone meal often leads to a slight increase in milk production; that it helps the cows to carry their calves to maturity, and that cows which have received bone meal are in better condition, and drop stronger calves, on this account, after forced production.

One correspondent writes:

We have run from 50 to 100 cows on year tests every year for the past five years. We found when the cows on these year tests were getting the ordinary grain ration, without minerals, they finished their year in very thin condition, and in many cases dropped calves that were weak, a few calves dying at birth. For the past three years we have been feeding bone meal in the ration, and we have noticed that the cows finished their 365-day tests in a much more healthy condition, not in the least showing the strain; and the calves they drop are much heavier and more robust at birth.

Another correspondent writes as follows:

Down here in Virginia, in this particular section, where the soil is not rich in calcium, we feel that mineral supplements are especially helpful.

We have established to our own satisfaction that cows producing a heavy flow of milk, in our herd, maintain such production longer and develop a larger and better calf than they did before we started on mineral supplements. We are also satisfied that our young stock is "growing out" faster and better than before the use of such mineral supplements was employed.

I assure you that the above statements are based upon actual figures and not upon general impressions.

From Dr. C. H. Eckles, of Minnesota, I have the following statement as to the practical aspects of this matter:

The question of a mineral deficiency in the ration fed dairy cattle is of special interest to cattlemen in Minnesota. In addition to the question of a possible deficiency in calcium and phosphorus under ordinary conditions of feeding, as the result of high-milk production, we have a definite area in this State where the question is acute even among dairily herds of average productive capacity.

The practice of adding mineral supplements to the ration of high-producing cows is becoming common among skilled feeders, especially when feeding for

the maximum production, as under official test conditions. These practical herdsmen are of the opinion that mineral supplements are beneficial.

The particular area where the problem of mineral deficiency is the most pronounced is a region just east of the valley of the Red River, extending a length of over 200 miles and including, roughly, 8,000 square miles. Constant complaints are received from livestock growers in this area of depraved appetite, as shown by animals chewing boards, bones, etc. These animals decline in milk more rapidly than normal, and it is stated that the growth of the young is not normal.

The forage grown in this region apparently is deficient in mineral matter, since it is claimed by farmers that animals thrive better on feeds shipped in than on home-grown rations.

In this same region the water supply contains a very high magnesium content, which may be a factor to consider. It has been found that the use of bone meal or rock phosphate relieves the pica, and the use of these and other mineral supplements is rapidly extending.

The experiment station has not as yet had an opportunity to investigate the problem, and the information given is based largely upon observation of county agents and farmers.

It is impossible to say just how much truth there may be in these informal observations which I present, but it is impossible to ignore such testimony. It seems likely that it is at least in part correct, and it should certainly lead to carefully controlled experiments to establish the facts, whatever they may be.

Let us examine the scientific evidence on the subject. Of this sort we have, principally, balance experiments of short duration involving the comparison of body income and outgo, and long-time feeding experiments in which results are obtained either by the comparison of the production and other performance of a given group of cows as affected by treatment as to mineral nutrition in consecutive periods of lactation, or by the comparison of results obtained with groups of cows fed simultaneously under different treatments as to mineral nutrition.

The short-time balance experiment has the advantage of yielding the quicker, the more detailed, and the more definite results, and the disadvantages of involving a considerable factor of error, and being so expensive as practically to result in our attempting to judge of the mineral nutrition of the whole year from data covering relatively short and sometimes imperfectly representative portions of the same.

The balance experiments bearing on this subject, in which rations of normal practical feeds were used, have been conducted by Meigs, of the Department of Agriculture; Hart, of Wisconsin; and by the writer, at the Ohio Agricultural Experiment Station, working, in each case, with the cooperation of associates.

In experiments by Meigs, Blatherwick, and Cary (1), eight four-day balances were determined, with normal rations, though the grain and hay were fed in alternate days, and disodium phosphate was given with the grain in half of the tests, the calcium intake being about the same in all cases.

In my opinion, the balance periods were too short to give reliable results; and the experiment was attended by many unfavorable conditions, which the authors record, among them abortion, extreme nervousness and discomfort of the cows, the development of abrasions on hips and shoulders, refusal of one cow to lie down during 60 hours, refusal of a part of the feed, and, in one case, there was no preliminary feeding under the conditions of the experiment.

We agree with the authors in the belief that a part of the added sodium phosphate was utilized, but do not feel that the evidence warrants their conclusion that the nervous effect of the experimental routine interferes especially with calcium assimilation, or with their provisional conclusion that the feeding of sodium phosphate favors calcium assimilation.

There was storage of calcium in three balances and loss in one on both treatments—that is, with and without phosphate—and the total calcium storage was the same. Including also the two losses, the net calcium storage was the greater without phosphate.

With each treatment there were two consecutive four-day balances. If these are united, making four eight-day balances, the calcium storage was greater without the phosphate. There was no evidence of a critical situation with reference to calcium in the nutrition of the dry cow.

In a later paper, Meigs and Woodward (2) reported observations of the effects of feeding sodium phosphate to cows, during a dry period of about 60 days, on the milk yield of the first calendar month after parturition. The grain and hay were fed on alternate days, the sodium phosphate being fed with the grain.

It was the authors' belief that the milk yield of the experimental subjects had been reduced by several years' feeding on rations characterized by insufficiency of either calcium, or phosphorus, or both, and by feeding with little or no access to pasture.

They concluded that, under these circumstances, a greatly increased milk yield can be brought about by giving sodium phosphate with the grain—grain and hay being fed on alternate days.

So far as we know these results have not been confirmed.

The authors state that the quantitative results of the experiment are significant only for the special conditions under which these experiments were carried out. It was neither claimed nor shown that the results applied to general conditions of normal dairy practice.

It is our feeling, therefore, in consideration of the nature and extent of the evidence, that the results should be regarded as inconclusive.

Hart, Steenbock, Hoppert, and Humphrey(3) found that a cow can store calcium more liberally from fresh, green alfalfa than from dry alfalfa hay, and that it is possible to maintain a positive calcium balance during liberal milk production on dry alfalfa hay, provided the hay be cured under caps or covers.

This work of Hart and associates seems to explain the state of nutritive depletion of the cows of the Beltsville farm of the Department of Agriculture, as commented upon by Meigs; and this finding by Hart tends, therefore, to confirm Meigs's conservatism in stating that his results on the effects of sodium phosphate feeding applied only under the particular conditions obtaining in his experiments, and tends also to lessen the significance of these results in relation to cows maintained with the usual summer access to pasture.

The writer(4) and associates, at the Ohio station, conducted a series of 60 complete mineral balances with milk cows, largely in periods of 16 to 20 days duration, in which a great variety of natural, practical feeds and mineral supplements were compared as to influence on the mineral nutrition; and a program of tests was con-

ducted, both with and without added mineral supplements, covering in a disconnected series of observations the entire year of lactation and gestation. The subjects were of the better class of Holstein cows, mostly grades, but better than average producers.

This work involved complete balances of income to outgo of sodium, potassium, calcium, magnesium, sulphur, chlorine, phosphorous, silicon, arsenic, and nitrogen.

All animals were fed on normal, dry, winter feeds, including timothy, clover, or alfalfa hay (cured in the usual manner in the windrow, exposed to the sun), and in some cases also corn silage.

In addition, mineral supplements were used, always under conditions affording, by comparison, a basis for judgment as to their utilization.

The following are the mineral substances fed: Calcium carbonate, steamed bone flour, sodium chloride, calcium lactate, calcium chloride, precipitated bone phosphate, Fowler's solution of arsenic, and a half-and-half mixture of precipitated calcium carbonate and precipitated bone phosphate.

In 49 of the 60 periods the cows were producing milk liberally, in the first half of the period of lactation. In every one of the 49 cases there was loss of calcium from the body; and we had exhausted our ingenuity to devise rations which would cause calcium storage. We have, therefore, demonstrated very thoroughly that under the conditions of our experiments, with cows in full milk, on normal winter rations, with or without mineral supplements, there is loss of calcium from the body.

Our series of tests covering the entire year also showed that, late in the period of lactation, under the same conditions of feeding as in the 49 cases of loss of calcium, the calcium balance normally changed from loss to gain. When the milk production had fallen off to such extent that the cow gave off calcium no more rapidly than she could assimilate it, then she was able to maintain calcium balance or to store calcium.

The exact point in the reduction of milk flow at which calcium loss changed to gain was not determined, but with our dry feeds, and hay cured exposed to the sun, we did not observe calcium storage in cows giving more than 10 pounds of milk per day.

As already stated, however, Hart has shown that with alfalfa hay cured under caps, it is possible for a cow to store calcium during much more liberal milk production.

An outstanding point in our work was the peculiar unresponsiveness of the cow to the calcium intake. During liberal milk production, with very much more calcium in the ration than the cow could utilize—a large part of it even in water-soluble form—she continued to give off more calcium than she obtained in the ration.

Evidently some condition essential to the efficient utilization of calcium was lacking—and perhaps may normally be lacking in practical winter feeding.

Under the conditions prevailing it was clear that the calcium of the skeleton was more readily available for milk formation than was even the water-soluble calcium of the ration.

In these experiments the losses of calcium were somewhat more extensive when the roughage was timothy hay than when it was

clover or alfalfa, but the cows were as unresponsive to increase of mineral nutrients through changes of feed as to such differences as due to the addition of mineral supplements.

In our experiments we obtained no results which would warrant the positive recommendation of mineral supplements (other than common salt) for cows. They may be useful, but my extensive experiments have not shown them to be so.

To summarize:

(1) Veterinarians recognize mineral deficiency of the ration as a cause of disease in cattle.

(2) There is plausible ground for inference that lack of mineral nutrients is a factor in the cause of the nutritive depletion of the overtaxed milk cow.

(3) The informal observations of successful practical dairymen sustain the idea that under certain conditions of soil and climate milk cows suffer, in important ways, on account of insufficiency of mineral nutriment.

(4) There is informal evidence that, under favorable conditions as to soil and climate, but with forced feeding, as in 365-day tests of milk production, cows may suffer from mineral depletion.

(5) The use of mineral supplements, such as bone flour, under certain unfavorable conditions of practice, is thought, by many successful dairymen, to be beneficial.

(6) Under favorable conditions the milk cow normally loses calcium while she is fresh, and gains calcium late in the period of lactation, and while she is dry.

(7) Extensive laboratory studies have not shown that the use of mineral supplements is beneficial, though we concede that it may be. In metabolism experiments the milk cow is peculiarly unresponsive to increase of mineral nutrients, either by change of normal feeds or by the feeding of mineral supplements. There is a fair question, however, as to the extent to which these results of mineral balance experiments, on a laboratory basis, apply under conditions of practice.

(8) Fresh forage is more favorable to calcium storage than is dry hay; and hay cured in cocks, under caps or covers, is more favorable than is hay cured in direct exposure to the sun.

(9) The difference between winter roughage and fresh, green forage, then, in the light of our present incomplete understanding, seems to be a secondary factor in the complex which causes fresh cows on winter rations to draw on their mineral reserves for calcium, the most important causes being the exaggerated impulse of the improved cow to secrete milk and her limited ability to assimilate calcium. The ultimate cause of this limited ability to assimilate calcium has not been determined.

(10) The results of investigation emphasize the necessity of a dry, resting period. The feeding during this time should be sufficiently liberal to permit the building up of extensive reserves of nutriment which shall protect the vitality of the cow and permit the full expression of her capacity to produce milk during the following period of lactation.

(11) The primary opportunity for building up the nutrient reserves of the cow is during her growth as a heifer. Dairymen

have debated the question as to the wisdom of liberal feeding during this period, with the preponderance of sentiment in the affirmative. The facts as to the mineral metabolism of the cow suggest the great desirability of making the most of the storage or constructive possibilities of the animal at this time.

(12) We have found (5) that a practical way to feed mineral nutrients to cows is to allow free access to a mixture of 1 part of salt to 4 parts of bone flour. The special steam bone of the gelatin manufacturer is more agreeable to handle, and more acceptable in a dairy barn, and may be safer to feed than is fertilizer bone.

(13) The important points regarding this problem, which remain to be solved, apparently by carefully controlled, long-time feeding experiments under the conditions of practice, are the following: What conditions as to feeding and milk production make it possible, and what conditions make it impossible, for a cow to restore the mineral overdrafts of the early part of the period of lactation before the birth of the next calf? The critical considerations in this connection are (1) leguminous roughage as compared with gramineous roughage, (2) fresh, green as compared with dry forage, (3) the method of curing hay, and (4) the conditions under which mineral supplements will be utilized.

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Chairman JEFFERS. Is there any discussion of Doctor Forbes's paper?

Sir ARNOLD THEILER (South Africa). I have listened with very much interest to the paper by Doctor Forbes, and it so happens that I am engaged in studies similar to those he has mentioned.

I come from South Africa, which in certain parts suffers very much from drought. In these countries a disease is observed and has been studied by me, which has also been studied by Doctor Forbes, lamziekte. Lamziekte, however, as experiments have proved, is not a deficiency in the minerals, but a deficiency of phosphorus which leads to the acquisition of that particular disease. To make quite clear: If a pasture is deficient in phosphates then the cow begins to look around for that substance. It eats bones and all sorts of rubbish, and in doing so that cow may find a substance of an animal nature which has undergone decomposition, in which a toxin has been formed, and that cow which eats that rubbish, or that toxic bone goes down with that disease—thus the connection between the two

things is, in the first instance, a phosphorus deficiency, and, in the second instance, a toxin produced by the rubbish bacteria in bones and any nutritive substance of a nitrogenous nature. But the fact, nevertheless, remains that as soon as you begin to feed bone meal you stop that disease, because you now stop the primary conditions leading to it.

In carrying out these experiments, however, we have seen that the administration of phosphorus has an enormous influence on the development of the animals in that particular country, and what your farmers have noted, as Doctor Forbes has quoted in his report, I am able to support entirely by experiment.

We have carried out these experiments on a very large scale, and we have found that as soon as we feed bone meal the calves grow faster; they grow to a greater weight; the cows will yield more milk, their calves are bigger, and the lactation will last longer. In every respect we have found that the addition of bone flour or bone meal—in those countries of which I am speaking—makes a more profitable animal in every respect.

In this particular case there can not be any calcium deficiency, because it happens to be in a country rich in calcium, and the experiments have shown that in supplying phosphorus alone it will produce the same results.

However, in that part of South Africa where we have a little rainfall we have different conditions. Again we have the condition of the eating of rubbish and of bones, but associated with it we have usually a disease which is claimed to be rickets. It is nothing of the kind, as biological investigations have shown. The name to describe it has yet to be found, but the fact, nevertheless, remains that in these areas we have a disease of the bone with enlargement and fragility of the bone, which can be cured by the supply of phosphates. But in this particular country we have also a deficiency of lime, and experiments have shown, if we increase the lime for these particular cattle we do not get any improvement, but as soon as we give them phosphates the improvement takes place; we are able to cure the animals and we are able to prevent the disease. It would thus appear that as soon as we supply the minimum quantity, or, let us better say, the optimal quantity, of the phosphates, the calcium looks after itself in this particular country.

However, gentlemen, don't go away with the idea that I am saying that calcium is not required. I am speaking only of the growth of animals; and under those particular conditions I have observed that these conditions are not results of intensive milk yield, and intensive farming, and what has been described by Doctor Forbes probably will apply to those, but in speaking of the phosphorus I, nevertheless, mention one thing, that practically every animal, every cow, every calf, requires a different dose of phosphate. What appears to be the optimal quantity for one animal is a minimum quantity for another one, and when some farmers say they have not had any good results from the application of phosphorus the explanation is that they have not found the optimal quantity for that particular animal. I thank you very much. [Applause.]

Chairman JEFFERS. Is there any further discussion?

Dr. E. B. MEIGS. In reference to our 1919 experiments, Doctor Forbes has touched on the old bone of contention between us, that is to say, the question as to whether the experimental routine which has to be employed in order to follow the calcium balances of animals can under any circumstances have the effect of reducing the animals' power to assimilate calcium.

I would like to speak of just one or two points with regard to these experiments, and then to mention very briefly an experiment that we carried out in the spring, along the same line, because I think that this question, calcium metabolism, can not be further satisfactorily investigated without carrying out numerous further balance experiments on calcium. If the conditions of the experiments are likely, under any circumstances, to interfere with the animal's power to assimilate calcium, it is extremely necessary that anybody who is undertaking such work should at least consider the question whether this is the case or not.

We think that the most important result of the 1919 experiments to which we referred is that they do contain evidence that our animals at least were disturbed by the conditions in such a way that their power to assimilate calcium was lessened. We think this because they were on the dry rations, on which they had been kept for a number of years past, and on which they have been able to continue their functions with a fair degree of satisfactoriness. But, in spite of this, as far as the cows themselves were concerned, they were actually losing calcium from their bodies. These cows were in the late stages of pregnancy, at which time a large amount of calcium has to be added to the bones of the embryo within the cow. It is quite easy to calculate in a rough way how much this ought to be, and from such calculations we found that while our cows were on the average in positive calcium balance, when you regard the cow with her unborn calf as a unit, with regard to the cow herself she was almost certainly in negative calcium balance because the rate at which she was assimilating calcium was less than half enough to supply what the unborn calf needed, and which would of course be lost by the cow as soon as the calf was born.

We think, therefore, that these experiments are pretty strong evidence that the routine which is necessary in balance experiments is likely to disturb animals to such an extent that they don't assimilate calcium the way they do under perfectly normal circumstances.

We have further evidence from these experiments which it is impossible to discuss in detail. The cows showed not only the negative calcium balances, but as a rule they showed some interference with appetite, and also other effects of not feeling entirely happy under the experimental routine.

Last spring, in order to test this question further, we made experiments in which cows were kept for 36 consecutive days on balance experiments. The whole 36 days were divided into 4-day periods, and the balances were followed for each 4-day period. One of the cows was giving a large amount of milk, between 35 and 40 pounds, the other was giving something like 15 pounds. This latter cow was very decidedly disturbed by the experimental routine, and kept going off feed to such an extent all through the experiment

that we didn't consider that she could be regarded as at all a normal case. She was, on the whole, in negative calcium balance all through the experiment, in spite of the small amount of milk she was giving. The other cow was, luckily, very little disturbed. She refused very small portions of her hay during the first 8 or 10 days of the period, but ate up the grain all the way through, and during the rest of the experiment was apparently perfectly comfortable under the conditions. We began following her balances as soon as she was put under the experimental conditions, and in the first 4 days we found she had a negative calcium balance of 20 grams, approximately. In the next 4 days the negative balance was 12 grams, in the third 4 days it was on the average—these are daily amounts—something like 8 or 10 grams. It went on, very slowly improving from that period until the end of the 36 days, when it finally got down to a negative balance of about 6 grams.

The results of this experiment we think indicate strongly that disturbance may have an effect on the cow's power to assimilate calcium; nevertheless, it makes us feel as if we ought to take off our hats to Doctor Forbes in admitting that it is really quite a difficult matter to get a cow which is yielding a large amount of milk in positive calcium balance.

This animal was fed 10 or 12 pounds of alfalfa hay a day and in spite of that, and in spite of the fact that she was continued on this diet for 36 days, so that she had a good chance to get entirely accustomed to the conditions, she was still showing a negative balance of about 6 grams a day at the end of the period. [Applause.]

Chairman JEFFERS. Is there any further discussion of this paper?

Mr. F. B. MORRISON (University of Wisconsin). In connection with the discussion this morning, showing it is so difficult to get a cow to store calcium, I might mention the trials which were conducted at the University of Wisconsin this summer. Professor Hart has carried on several experiments under dry winter conditions and under summer conditions this summer. He used clippings simulating pasture from a lawn which was rich in calcium. A cow producing 50 pounds of milk tended to lose calcium in spite of being fed this fresh pasture, which, of course, contained an abundance of vitamin D. However, we made very large allowances of bone meal, I think 200 grams a day to that ration, and when we did that, definite positive balances were secured, but that is an extremely large allowance of bone meal. Whether a somewhat smaller allowance would have performed the same result is still a matter of question. This has led Professor Hart, in recent conversations and statements to farmers, to advocate very strongly the use of bone meal or food supplying calcium on pasture, because apparently it is easier to get the positive balance on such conditions when the supplement is added to the fresh green forage than it is under winter conditions.

Chairman JEFFERS. Is there any further discussion?

Prof. C. C. HAYDEN (Ohio Agricultural Experiment Station, Wooster, Ohio). From our experimentation recently, Mr. Perkins and Mr. Monroe have conditioned some mineral balances on wide and narrow rations. I would like to have them give you just a word of what they have.

MR. C. F. MONROE (Ohio). Mr. Chairman, in our work we have used natural water in preference to distilled water. I don't know whether this made any difference in our work or not, but our results have shown that the cows tended to remain in balance, almost neutral, except those cows which were receiving large amounts of clover hay. The amounts were about 12 pounds. These cows tended to store calcium slightly.

MR. A. E. PERKINS (Ohio). In connection with the same work that Mr. Monroe just spoke of, we had one cow on a ration of 1 to 11 and she was producing 50 pounds of milk per day. The negative calcium balance was something under 4 grams, and that strikes me as quite different from the results that have been secured. We are unable to say whether this condition, or differences from the results of other investigators, is due to the use of natural water, or possibly to the use of clover hay, which was selected in the field and was secured partly in the shade—that might have had something to do with it. [Applause.]

Chairman JEFFERS. The next paper is on "The relation between the quantity and availability of calcium in the ration and the milk yield of milk cows," by Dr. E. B. Meigs, physiologist, United States Department of Agriculture.

THE RELATION BETWEEN THE QUANTITY AND AVAILABILITY OF CALCIUM IN THE RATION AND THE MILK YIELD OF DAIRY COWS.

EDWARD B. MEIGS, M. D., research laboratories, Dairy Division, United States Department of Agriculture.

It is a common observation that dairy cows are often exhausted by a period of unusually heavy milk yield. Although they may be up to their normal weight and appear to be in good condition after such a period, there is, nevertheless, frequently difficulty about getting them with calf; and, after this has been accomplished, it is not uncommon to find that the yield for the succeeding lactation period is much less than the previous one. Such results would be explained if it could be shown that there is some dietary essential which can be stored in relatively large quantities in the bodies of mammals, and which is frequently excreted by milking animals in larger quantity than is provided in the food. In the last few decades much evidence has accumulated to indicate that calcium is such a dietary essential.

In 1898, Anger carried out 22 experiments on milking cows in which the calcium balances were followed.¹ The animals received from 17 to 71 grams calcium daily in their food, and gave from 1 to 16 kilograms of milk daily. The calcium balances were sometimes negative and sometimes positive, but tended in general to be negative, and particularly for the cows which gave the largest amounts of

¹ Anger, A., Ueber den Umsatz und Ansatz der Aschenbestandteile, vornehmlich von Kalk, Magnesia, Kali, und Phosphorsäure, bei Milchkühen: Inaugural Dissertation, Heidelberg, 1898. The figures given by Anger for the calcium content of some of the foods used by him depart widely from the average, and there are other features of the work which make it necessary to regard the balances as rough preliminary approximations.

milk and received the smallest amounts of calcium in their rations. The average daily calcium balance was -1.74 grams.

In 1909, Hart, McCollum, and Humphrey carried out an experiment in which a milking cow was fed for 111 days on rations low in calcium, and in which the calcium balance was determined at intervals. The results would indicate that the cow lost calcium from her body at the average rate of about 18 grams daily during the whole period of the experiment. Her milk yield was 17.5 kilograms daily at the beginning of the experiment and was still 12.7 kilograms daily at the end—a remarkably small reduction in yield considering the quantity and quality of the food supplied and the marked negative calcium balances.²

In 1911, Fingerling studied the effects of rations low in calcium on the milk yield and on the calcium balance in goats.³ When the animals were put on the low calcium rations they went into negative calcium balance, but sustained their milk yield remarkably well for a period of several weeks. At the end of this time, however, the milk yields began to fall off quite rapidly, while the calcium balances became less markedly negative. It was found possible to render the calcium balances positive and to restore the milk yields to a greater or less extent by adding inorganic salts of calcium and phosphorus to the rations.

In a comprehensive series of experiments which have been discussed in another paper at this congress, Forbes has consistently found marked negative calcium balances in liberally milking cows, even when these were fed on excellent rations high in their natural calcium content.⁴

The evidence so far presented indicates that mammals giving fairly large quantities of milk are sure to be found in negative calcium balance when their rations contain only small amounts of calcium; and that, even when the rations contain large amounts of calcium, the balances are still very likely to be found negative. Anger's results and Fingerling's, however, indicate that with rations rich in calcium the balances may sometimes be positive, even though the milk yield be fairly large. The evidence under consideration indicates further that milk yield may be remarkably well sustained for a considerable period in the face of a persistently negative calcium balance.

Both Anger and Forbes carried out considerable numbers of individual experiments with cows which were giving various quantities of milk and receiving various quantities of calcium in their food. The results indicate, on the whole, as might be expected, that the calcium balances are more likely to be negative and that the negative balances are likely to be larger, the larger the milk yield and the smaller the amount of calcium received in the food. But they indicate also that there is no constant mathematical relation between calcium intake, milk yield, and calcium balance; on the contrary, the relation is often irregular, and in such a way as to indi-

² Hart, E. B., McCollum, E. V., and Humphrey, G. C. *American Journal of Physiology*, 1909, XXIV, p. 86.

³ Fingerling, G., *Die landwirtschaftlichen Versuchs-Stationen*, 1911, LXXV, p. 1.

⁴ Forbes, E. B., with collaborators; *Ohio Agricultural Experiment Station; Bulletin* 295, 1916; *Bulletin* 308, 1917; *Bulletin* 330, 1918; *Journal of Biological Chemistry*, 1922, LII, p. 281.

cate that factors other than the milk yield and calcium intake may have a marked effect on the calcium balance.

That such other factors influencing calcium metabolism exist is abundantly shown by the results of various independent lines of investigation. One such line is that concerned with the causation of rickets. Rickets is a disease in which the bone formation is faulty, and it has been found that the feeding of rations low in calcium to growing animals may lead to the deposit of too little calcium in their bones. The addition of cod-liver oil to such rations, however, greatly facilitates the deposition of the bone salts, and this fact has given rise to the view that cod-liver oil contains a dietary factor which facilitates calcium assimilation. The faulty bone formation which occurs in rickets may also be corrected, under certain circumstances, by exposing the animals concerned to sunlight or to ultraviolet light, which indicates that calcium assimilation may sometimes be influenced in very unexpected ways. A review of the subject of rickets with numerous references to the literature has recently been published in *Physiological Reviews*.⁵

Evidence bearing more directly on the factors which influence the calcium assimilation of milking animals has been collected at the University of Wisconsin.⁶ It has been shown that calcium is better assimilated by cows and goats from fresh green plant material than from the same material after it has been dried and turned into hay; also that it is better assimilated from alfalfa hay cured under caps than from the same kind of hay cured in windrows with many hours' exposure to direct sunlight. In still other experiments, results have been obtained which indicate that cod-liver oil added to the rations of goats may facilitate calcium assimilation. The work at Wisconsin has extended that on rickets by showing that cod-liver oil may facilitate calcium assimilation in adult animals as well as its deposit in the bones of growing animals, and by adducing evidence for the view that a dietary factor which facilitates calcium assimilation is found in fresh green plant material and in well-cured alfalfa hay, as well as in cod-liver oil.

The work so far reviewed shows that the calcium balance in milking animals is influenced to a considerable extent by the quantity of the milk yield and of the calcium intake but that it may be influenced also by apparently unrelated factors, such as unknown dietary essentials and sunlight. It will be a matter of great difficulty, if it is possible at all, to work out the quantitative effects of all these influences; and, in the meantime, it is in the highest degree desirable, from every point of view, that quantitative knowledge should be acquired regarding the manner in which the calcium requirements of milking animals may be economically met, the conditions under which calcium deficiencies are likely to make themselves felt in practice, and the physiological effects of such deficiencies. To acquire such knowledge it is obvious that long-continued experiments must be carried out on numerous animals under conditions approaching those which obtain in practice; it is impracticable to determine calcium balances in such experiments; and the

⁵ Park, E. A. *Physiological Reviews*, 1923, 111, p. 108.

⁶ Hart, E. B., with collaborators. *Journal of Biological Chemistry*, 1921, XLVIII, p. 33; 1922, LIII, p. 21; 1922, LIV, p. 75.

evidence obtained from them must therefore be regarded as incomplete in its bearing on calcium metabolism. But the results can be made to have a very direct practical bearing, and the tentative conclusions regarding calcium metabolism which can be drawn from them may be made to serve a useful purpose as a basis for the planning of future experiments.

Experiments to determine the physiological effects of rations with different calcium contents, but otherwise as nearly as possible similar, have been in progress at the Beltsville station of the United States Department of Agriculture for about three years. As all concentrates and many roughages contain rather small quantities of calcium, it is easy to devise rations low in their natural calcium content. Those used in the experiments under consideration consisted of grain mixture 2⁷ combined with timothy hay as the chief roughage and sometimes also with corn silage. The effects of these rations, which will be designated B, have been compared with those of others, to be designated C, and exactly similar except that calcium carbonate was added to the grain mixture in the proportion of 3 parts to 100. It was felt that rations B and C might both be deficient in some dietary essential, and a third set of cows was therefore fed on ration A, in which alfalfa hay was substituted for the timothy of ration B. As alfalfa has not only much more calcium, but also more protein, than timothy hay, a modified grain mixture was used with ration A, which will be called grain mixture 1.⁸ Rations A and B contained approximately equal proportions of protein and were otherwise as nearly similar (except for their calcium content) as they could be made in view of the fact that alfalfa was the chief roughage in one and timothy in the other. Rations A and C contained approximately equal amounts of calcium.

It has been the plan to feed all the cows used in these experiments as much of the various rations as they could eat without suffering from digestive attacks, and to keep detailed records of the food eaten, of the milk yield, of the changes in body weight, and of the general reproductive history. The fat content of the milk has been determined and recorded once a month. In addition, all the cows have been weighed on three successive days once a month, and records have been kept of their heat periods, when they were bred, and when they calved or aborted.

There was no difficulty in getting the cows to eat more of all three of the above-described rations than they required according to any of the feeding standards, and they have all shown a considerable tendency to increase in body weight during their lactation periods and to become fat under the experimental conditions. Those on rations B and C consumed a decidedly larger surplus in total digestible nutrients above their requirements than those on ration A, but did not gain weight any faster. As all three rations contained large proportions of protein, the cows consumed about 40 per cent more protein than they required according to the most liberal of the feeding standards.

⁷ Grain mixture 2 contained 30 parts corn meal, 20 parts wheat bran, 25 parts cottonseed meal, 25 parts linseed meal, and 1 part NaCl.

⁸ Grain mixture 1 contained 40 parts corn meal, 30 parts wheat bran, 20 parts cottonseed meal, 10 parts linseed meal, and 1 part NaCl.

The calcium content of the timothy hay used has been frequently determined; and that of the alfalfa, once or twice. The timothy has contained from 0.17 to 0.36 per cent of calcium, the great majority of it running less than 0.25 per cent. The alfalfa hay has contained from 0.9 to 1.3 per cent calcium.

The cows used have been purebred Jerseys and grade Guernseys.

The experiments were begun, of course, without any definite knowledge of the character of the effects which might be produced on milk secretion by feeding rations low in calcium. In view of the results of Hart, McCollum, and Humphrey, and of Fingerling, above cited, it seemed likely that these effects might be rather long delayed. It was planned, therefore, to keep all the animals for long periods on the rations whose effects were to be studied. It soon became apparent, however, that when cows of the Jersey and Guernsey types, which were giving about 30 pounds of milk daily, were changed from ration A to ration B, the effects of the latter on milk yield showed themselves much sooner than had been expected. It was often possible to effect this change without causing any reduction in the total amount of food eaten by the cow and without causing any immediate drop in milk yield. But within a week the milk yield begins to drop more rapidly on ration B than it does on ration A, and this drop continues to become more rapid for the next six weeks or more.

It has been found also that the manner in which milk yield falls off on ration A, and its rate of fall, is fairly uniform, being less rapid usually during the fourth, fifth, and sixth months of lactation than either before or afterwards. A number of cows have therefore been run for a year or more on ration A, in order to get some approximation to the average manner in which milk secretion behaves on this ration, while others have begun their lactation periods on this ration and have then been changed either to ration B or to ration C at the end of the third clear calendar month of lactation. In still other cases cows have begun their lactation periods either on ration B or on ration C, and have been continued on these rations for long periods.

A graphic representation of the experimental results for those cows which were giving more than 25 pounds of milk daily when they were put on the various rations to be studied is given in Figures 1 and 2. The results are not yet as numerous as could be wished, but they have been quite consistent, and there is good reason to believe that they give at least a fair approximation to what will be obtained in future similar experiments on cows of the Jersey and Guernsey types and with hay of the same character as that which we have used. They indicate that ration B produces a very much more rapid drop in milk yield than does ration A, while ration C is intermediate, but tends on the whole to produce effects more like those of ration B than of ration A, especially after it has been fed for some time.

The results given in Figures 1 and 2 are supported by the results of other experiments in which the milk yields were lower when the animals used were put on the rations to be studied. The effects of deficient rations on lower milk yields, however, are longer delayed and less generally noticeable than on higher ones, and it is not possible to give them in detail in this paper.

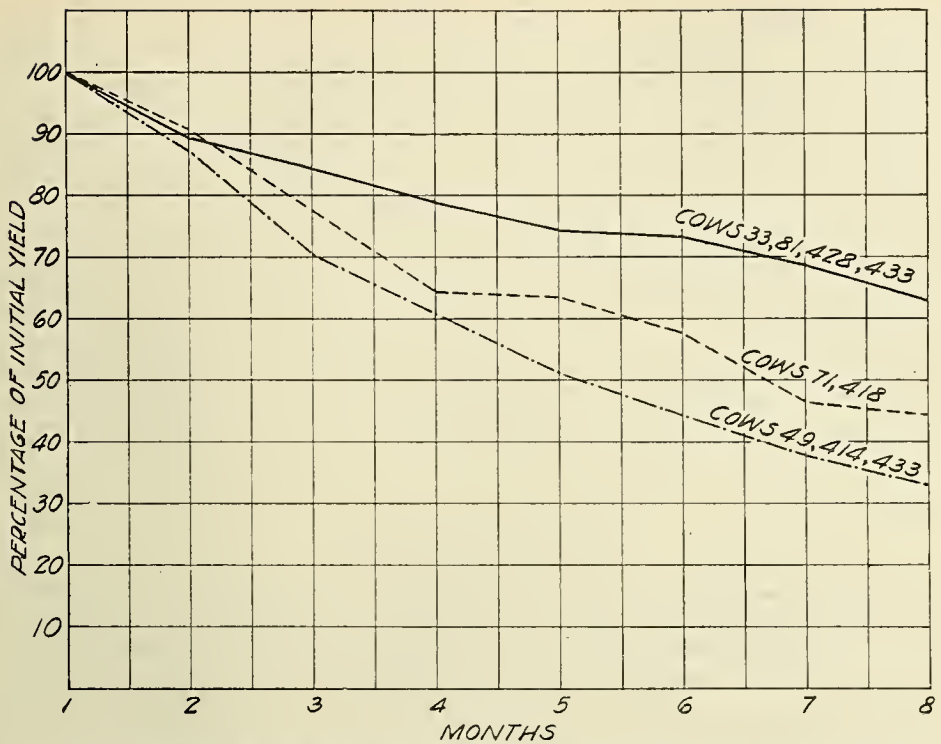


FIG. 1.—Graphs showing the manner in which milk yield falls off on different rations. The continuous line represents the average yield of four cows on ration A; the dash and dot line, that of three cows on ration B; and the dotted line, that of two cows on ration C. All cows in this figure began their lactation periods on ration A; cows 49, 414, 433, 71, and 418 were changed to the other rations after some weeks in milk.

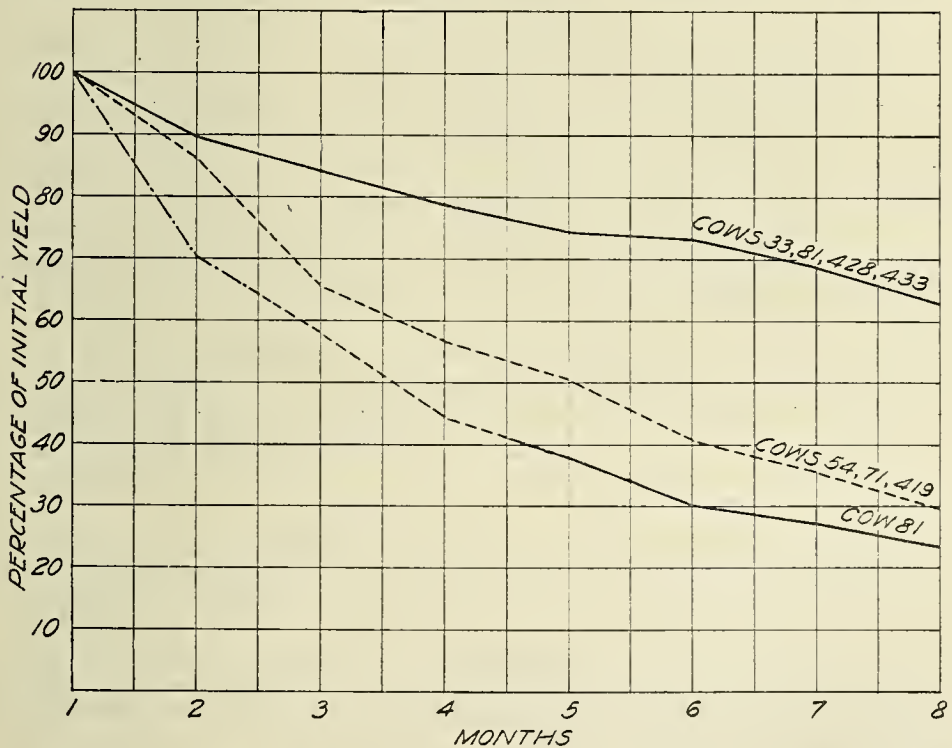


FIG. 2.—Graphs showing the manner in which milk yield falls off on different rations. The same conventions are used as in Figure 1. Cow 81 began her lactation period on ration B; cows 54, 71, and 419 began their lactation periods on ration C, and had also been on this ration for some weeks previous to calving.

The feeding of ration B has interfered greatly with the normal processes of reproduction.⁹ Of the five cows which have been kept farrow and milking for as much as three months on this ration, only one became pregnant as the result of the first service, and she aborted 10 weeks before the normal term of this pregnancy, and died 9 days after the abortion from an acute general infection. Of the others, one became pregnant after two unsuccessful services; the second has been bred five times unsuccessfully and is not yet pregnant; the third was bred five times unsuccessfully while milking, and became pregnant only after she went dry; and the fourth was bred seven times unsuccessfully while on ration B; and became pregnant only after being changed to ration C. No living calf has so far been obtained from any of them. Reproduction on ration C has been much more nearly normal than on ration B, and not very markedly inferior to that on ration A.

DISCUSSION OF RESULTS.

The milk yield, reproductive capacity, and general health of the cows on ration A have been very satisfactory, in spite of the fact that for three years these animals have had no pasture. It seems justifiable to conclude, therefore, that alfalfa combined with even a comparatively simple mixture of concentrates makes a complete or nearly complete ration for dairy cows. Ration C is fairly satisfactory for reproduction, but not satisfactory for milk yield; ration B, highly unsatisfactory both for milk yield and for reproduction.

It is a well-established physiological proposition that mammals readily absorb calcium from its inorganic salts; and it would be surprising that ration C, which contains liberal amounts of protein, of nutritive energy, and of all the mineral elements which are known to be necessary for nutrition, is so unsatisfactory for milk yield, were it not for the recent work on vitamins. It seems reasonable to conclude that alfalfa contains large amounts of a vitamin which is particularly necessary for milking animals. As it is desirable to designate this hypothetical material in some way and, at the same time, to avoid controversy, the phrase "alfalfa vitamin" will be used for the present to describe it, with the expectation that some better designation will be found when more knowledge regarding it shall have been gained.

In view of the work already cited which shows that calcium assimilation may be facilitated by the addition of vitamins to the ration, and in view of other work carried out at the University of Wisconsin which shows that calcium is better absorbed from rations like A than from rations like C,¹⁰ it may be regarded as not improbable that the alfalfa vitamin (which may or may not be a single chemical compound) facilitates calcium absorption, and that at least a part of the unfavorable effects of ration C on milk yield are due to the fact that milking cows fed on it get too little of the alfalfa

⁹ Previous work carried out at the University of Wisconsin has shown that rations low in calcium are unfavorable for the reproduction of dairy cows. See Hart, E. B., Steenbock, H., and Humphrey, G. C., Research Bulletin 49 of the Agricultural Experiment Station, University of Wisconsin, 1920.

¹⁰ Hart, E. B., Steenbock, H., Hoppert, C. A., Bethke, R. M., and Humphrey, G. C. Journal of Biological Chemistry, 1922, LIV, p. 75.

vitamin to enable them to absorb calcium as rapidly as they require it.

If the above hypothesis may be accepted as a basis for further work, the next important practical question to be answered is that regarding the distribution of the alfalfa vitamin in other foodstuffs. Is it present in all kinds of pasture grass, and in such quantity that the actual calcium content of the rations of cows on pasture may be neglected? Are other legume hays as good a source of supply for it as alfalfa? Finally, is there any parallelism between the natural calcium content of the various farm feeds and their content in this vitamin?

While further knowledge is being obtained, however, the results outlined have some immediate practical value. It would seem that dairy farmers are fairly safe if they can feed rations containing liberal quantities of protein, of nutritive energy, and of alfalfa. If alfalfa is not available, the curves of milk yield which have been obtained from the cows on ration A might be used as a standard to which dairy cows in general ought to conform. Certain individuals, will, of course, drop off in milk yield, even on ideal rations, more rapidly than the cows used in making these curves. But if most individuals in the herd fall markedly below these standards, it may be regarded as strong evidence for the view that the rations are in some respect deficient.

It is perhaps justifiable to regard the lowering of the milk yield and the failure to breed which occur on ration B as the cow's means of defense against the still more serious results which are likely to follow long-continued drains on the body stores of the various dietary essentials. It is probable that high-producing dairy cows have, to some extent, lost the tendency to immediately adjust their milk yield to every dietary deficiency, and are therefore more liable to serious catastrophes as the result of such deficiencies than are their less highly bred relations. Great weight ought not, of course, to be given to single cases, but it is impressive in this connection that the animal which maintained the best milk yield on ration B, and the only one which became pregnant as the result of the first service after three months on this ration, aborted 10 weeks before the normal term of this pregnancy and died 9 days afterward as the result of a general infection. This animal was only $4\frac{1}{2}$ years old when she died, and had been unusually healthy through the whole previous 2 years and eight months which she had spent at Beltsville. Only one other animal among the 20 used in these experiments in the last 3 years has died, and she resisted a somewhat similar infection for many months, instead of dying within 9 days.

Chairman JEFFERS. Is there any discussion of this paper?

Professor HAYDEN. Mr. Chairman, I would like to ask Doctor Meigs this question: If he thinks that cows can not be kept on dry feed constantly, why is it that one place I know of had success in keeping cows until they were 9 years of age on a ration which is pretty largely timothy hay and roughage and silage, and they have never had a bit of green feed, as far as we know? We have more than one cow of that character. It seems to me it is possible to

keep them a considerable time, although perhaps not with entirely satisfactory milk production, without green feed. Those cows have had a variety of other feed, a variety of corn silage and of grain, but no green feed.

C. L. SMITH (agriculturist, Union Pacific Railroad, Portland, Oreg.). The gentleman says that they had no green feed, but wouldn't you call corn silage green feed?

And then again this alfalfa ration: I found that cows, after being on an alfalfa ration and changed to an alfalfa hay forage, began to get off their feed; they didn't seem to digest it well; and then when we provided a rack in a corner of the yard where they had access to wheat straw they would consume from 5 to 8 pounds per day, per cow, and immediately improve in condition. Whether it was calcium phosphate or greater variety in ration I couldn't say, but I found it practical and profitable to supply cows where alfalfa hay was the principal part of the diet with all the wheat straw they wanted to eat. We got great deal better results when they had that than when they didn't have the wheat straw.

Doctor MEIGS. My answer to Professor Hayden would be, that I am very far from making the assertion that cows can not be kept without green feed, by which I think both Doctor Hayden and I mean fresh green material, either pasture or material which has just been cut from pasture and brought in. We would not think that silage could be included under green feed, in the sense that we are using it.

I don't think that our results are really enough to do anything except simply raise the question, whether or not the cows are suffering from the lack of pasture, and we intend, of course, to keep our eyes very closely on this point in the future and try to get some real data on it.

I would say, also, in answer to this suggestion, that the question of deficiency on timothy hay is, as far as our results go, entirely a question of the relation between milk yield and food—that is to say, between the amount of calcium lost in the milk and the amount that is supplied by the food. The experiments in which cows were kept indefinitely on timothy hay would not contradict ours at all, provided that it is true, as I think was said, that the milk yields were rather unsatisfactory.

One of the cows, which I mentioned in this paper, showed all the effects of timothy hay feeding, including a very rapid drop in milk yield. In fact, she showed the most rapid drop of any we put on it, and afterwards failed to conceive for five or six breedings. Finally she went dry, while she was still on this ration. Then, perhaps a month after she went dry, she came with calf, and she, therefore, had her whole period of pregnancy without any milk yield. She aborted in the summer, but in spite of the fact that she aborted about three weeks before she was due, she is giving a very good milk yield, and is not showing any signs of calcium deficiency. She was changed, of course, to alfalfa, as soon as she calved.

I think this is a pretty strong hint that dry cows can be fed on timothy hay.

I didn't catch the name of the gentleman who raised the point about wheat straw. He touches on the difficult question of the op-

timal quantities of calcium which are necessary in order to provide the best results. It seems to me that it is quite possible that cows may get too much calcium. Sir Arnold Theiler's discussion is a discussion of this same thing.

I have no doubt, and, as a matter of fact, it has been shown experimentally, that when rats are on a ration which is low in phosphorus, the results can be made worse without changing the phosphorus ration by simply adding calcium to it. This is a large job which we investigators of nutrition still have ahead of us: The determination of the quantitative requirements of calcium and other materials we have hardly had the courage to touch at all.

Chairman JEFFERS. It is getting a little late and we still have two papers whose authors are present. Mr. Erf, the head of the department of dairying, Ohio State University, will read his paper on "The value of minerals in the dairy ration."

THE VALUE OF MINERALS IN THE DAIRY RATION.

OSCAR ERF, professor of dairying, Ohio State University, Columbus, Ohio.

In feeding dairy cattle for high production, minerals have a place of importance equal to that of any other element in the feed. A certain amount of minerals is required by the cow for body maintenance; the conversion of feed into milk requires an additional amount; and the mineral constituents of the milk must also be supplied by the feed. The first two requirements are comparatively constant, but the third is a varying factor.

The recompounding of feed nutrients results sometimes in an unbalanced feed, which may prove to be desirable for an individual animal, or the reverse. This is a factor which can be regulated only by careful observation of the effects which it produces. The metabolism of the dairy cow is so complex that, as yet, no chemical method has been discovered by which definite results can be determined.

Since it is impossible to determine the results scientifically, in the purest sense—and in many instances not even comparative results can be obtained—the only method by which results can be measured with any degree of accuracy is by continued observation, over a period of years, of the effects produced. This is apparently of greater practical value than scientific determinations.

It is from years of observation, rather than from scientific conclusions, that the following statements regarding the value of minerals in the dairy ration are made.

In 1896 and 1897, while employed in a cheese and milk sugar factory in northeastern Ohio, my attention was first attracted to the value of minerals in the feed for dairy cattle and swine. The sugar-factory residue, which was the ash of milk, was considered a waste product, and it was difficult to determine what disposition should be made of it. It was finally fed to pigs; and when they showed decided gains, it was included in the dairy ration with corn, oats, bran, linseed meal, and clover hay. It seemed to be especially effective when the cows were on pasture.

When it was found that the cows responded so well to this feed, an analysis was made of the milk residue. This revealed nothing more than the mineral salts of milk. Naturally the question arose as to whether the good results should be attributed to the feeding of this material, or whether the improvement in the physical condition of the cows was due to other causes, and their milk flow just happened to be increased at this particular time; but from observations made since that time, it would seem that the feed, supplemented by these minerals, together with the inherent or intrinsic characteristics of the cows, were responsible for the increased production in this particular instance.

It was not my pleasure to make any further observations along this line until the year 1904, when at the Kansas Agricultural Experiment Station there was brought to our attention a herd of cows which were giving birth to soft-boned calves. These cows were fed principally on purified gluten and middlings. Doctor Barnes, who was then State veterinarian, was called and diagnosed the case as a probable lack of minerals in the feed. The addition of bone meal to the ration was prescribed, and while the cows did not apparently increase their flow of milk, the condition of the calves when born was greatly improved.

There were also reported a number of cases where cows fed on distillery slops and no hay, gave birth to calves with soft bones. Bone meal was again used as a corrective agency with good results. Our conclusions at that time were that bone meal was of value in the rations of the dairy cow, for the development of the calf, but that it had no direct influence upon the milk production.

Later observations led us to believe that the feeding of good hays was as beneficial as the use of bone meal, although in many of the dairies where distillery slops were fed, it was not desirable to feed hay to any extent.

At the Kansas Agricultural Experiment Station, in 1904 and 1905, tests were carried on for six months to determine the comparative value of different minerals in the feed, and again the results seemed to substantiate the opinion that the average calf from cows fed on a ration which contained bone meal and other minerals was considerably stronger than the ones fed largely on grains with a small amount of alfalfa hay. The cows given the minerals also seemed to be in better physical condition so that they actually produced more milk in the following period of lactation.

In 1906, a number of cows were being fed for maximum milk production, and it was here for the first time that the effect of minerals on milk production was really apparent. An Ayrshire cow that happened to be a wonderful milk producer was fed almost entirely upon concentrates, with only a small amount of alfalfa hay. This cow developed soft bones, and the belief at that time was that this was a case of osteomalacia, which was a disease or cancerous condition of the bone. The trouble was attributed to an infection, for the assurance was made by a physiologist that such a condition could not possibly arise from a lack of anything in the feed. However, the fact remained that other cows, in the same stable, fed on feeds high in mineral salts, with plenty of alfalfa hay, roots, and

bone meal, produced a large amount of milk and remained in fine physical condition.

The question as to whether the bone meal or the hays and roots were responsible for the increased flow of milk, led us to start a comparative experiment in which corn, oats, middlings, and linseed meal were fed to one group, with bone meal; to another group, with alfalfa; to a third group, with beets; and to a fourth group, with a combination of the three. During the experiment, the best results were obtained in the fourth group and the next best in the third group.

Beets, on account of their succulency and high mineral content, seemed to be a very desirable feed for dairy cows. They were not commonly fed at that time on account of the labor required to raise them. Recognizing the value of beets in the dairy ration, tests were conducted to determine the difference in value of the various varieties of beets. The results from feeding beets to the cows in the herd at the station proved clearly that the little red table beet, of which 14 per cent of the dry matter was mineral salts, was the best. We then conceived the idea of slicing the beets, grinding them, and drying the pulp. This proved to be a very good feed, but the idea was abandoned on account of the tremendous amount of labor and expense connected with it.

At about the same time the grinding of hays was tried, for the purpose of increasing their digestibility and making their mineral salts more available. The separation of the leaves from the stems and the grinding of the leaves only gave the best results.

Recognizing the value of minerals in the hay and in pasture grass, the experiment of soaking the minerals from the hays and then feeding them to the cows was tried. This proved to be of some slight benefit in increasing the flow of milk, but had no apparent effect upon the fat. Then alfalfa hay was ground into a fine powder and combined with salt and bone flour. Owing to the fact that at that time odorless bone meal could not be procured, the majority of the cows did not like the hay when treated in this way, but they would eat it when ground with common salt and mixed with water. However, the increase in production did not pay the expense involved in the preparation of the hay, and the practice was abandoned.

About the year 1907, I began to experiment with various feeds for cows with very high capacity for production, and have followed this line of study since that time. When a cow is in comfortable surroundings, well cared for in every way, is milked four times a day, and is given feeds that she likes, digests easily, and which contain the proper nutrients, then the conditions are ideal for determining the value of extra feeds or those which will increase the milk flow.

In the year 1908, we became interested in the development of a herd of Holsteins in Ohio. They were fed large quantities of beets, alfalfa hay, and silage, with a high protein ration consisting of corn, oats, bran, linseed meal, cottonseed meal, and distillers' grains. Large quantities of red beets were fed in order to secure the desired amount of minerals. The grains were all ground very fine, and the feeds were fed in a moist state. The cows were kept under very comfortable conditions and fed and milked four times a day. The result was that three world-record cows were developed in that herd,

all completing their records during one year. Guernseys, in another herd in the State, were fed and cared for in a similar manner, and the results were fully as gratifying.

In looking for a cheaper source for minerals, it was discovered that wet distillery slops were being wasted and that they contained a high percentage of ash. The feeding of vacuum-dried distillers' grains has become a common practice and is doubtless of some value in increasing the percentage of fat. Distillers' grains, if vacuum dried, are valuable not only on account of their mineral content, but also on account of the diastase formed in the process of fermentation.

These years of observation have led us to reach the following conclusions:

The ration for dairy cows which gives the best results is one which includes considerable bulky material with a low percentage of indigestible cellulose and a high percentage of protein, fat, and mineral constituents. Consequently, a ration which has proven excellent for dairy cows for high milk production has been found to consist of beets, ground alfalfa hay, or hay with a high mineral content (especially the third and fourth cuttings of clover), with only a small amount of silage (unless it contains an extremely large amount of corn grain), and in connection with the foregoing a grain ration of oatmeal, bran, linseed meal, cottonseed meal, and peanut kernel.

As the production increases, a variety of feeds high in mineral constituents should be added to the ration, and in connection with this some minerals must be fed if the best results are to be obtained. The greater the amount of milk produced, the more urgent is the need for these minerals. Minerals seem to exert a great influence upon the physical condition of the cow, and apparently the proteins, fats, and carbohydrates are not as thoroughly assimilated without the chemical action of the mineral salts.

The feeder must determine, to a certain extent, the character of the minerals for the individual cow. Some mineral salts are injurious to a cow, and act as a depressing rather than a stimulating agent. For instance, potassium nitrate retards the activity of the secretory glands. However, if large amounts of salt are fed, a small amount of potassium nitrate will assist secretion instead of retarding it. The amount of minerals to be fed is a matter which deserves very important consideration. Some minerals, if fed in large quantities, act as stimulants, resulting in a temporary increase in milk flow, but an eventual decrease.

The character of the minerals is also an important factor. Those are the best which are obtained through such feeds as grains, grasses, hays, beets, or beet pulp, fodders, and by-products of grains such as bran, linseed meal, vacuum-dried distillers' grains, peanut meal, etc. The amount of minerals which these various feeds contain is influenced somewhat by the richness of the soils upon which they grow; the maturity of the plant; the variety; and the method of treatment in cutting and curing. Soils may be rich in humus and yet not contain a high percentage of minerals. Hays cut when quite young, or just before blooming, as a rule contain the greatest amount of minerals. Hays that are not properly cured will lose many of their mineral salts. Forty-five per cent of the mineral salts can be washed out of alfalfa hay by heavy rains, and from 20 to 25 per cent

can be washed out of clover hay. This checks decidedly the digestibility of these hays.

The variety of the beet has much to do with the percentage of minerals which it contains. The little red beet is higher in ash than the larger beets and is better for milk production than the sugar beets. Carrots fed in limited quantities are also especially desirable.

Corn, oats, wheat, and other concentrates have, as a rule, a low percentage of minerals. Owing to this, high-producing cows are not able to obtain a sufficient amount of minerals from their feed, without overbalancing the other constituents. For illustration, a cow producing 130 pounds of milk a day, as has been done in several instances, would require about 1 pound of purified salts for the milk which she produces. She would not be able to consume an amount of feed sufficient to supply a pound of mineral salts, and for this reason minerals must be added to the ration.

The following minerals have been used to the greatest extent and with the best results: Calcium phosphate, calcium carbonate, magnesium sulphate, sodium, sodium phosphate, iodide of potassium, sulphur praecipitatum, black sulphide of antimony, arsenates, iron sulphates, bromides, and sodium chloride.

Minerals are essential only when the feed is of poor quality or when cows are producing more than the average amount of milk. Bone meal and hardwood ashes have been found to give the best results of any minerals, with the exception, of course, of salt. As production increases, it is often advisable to reinforce these with sulphur, potassium iodide, and other minerals.

When the quantity of feed is increased, salt is a very important factor, and a cow producing 70 pounds of milk containing 4.5 per cent butterfat should receive at least one-half pound of salt a day. There is no question but what salt is very essential, and it is probably responsible for the high production of hydrochloric acid in high-producing cows. Too much sodium is produced in the digestive tract, and the feeding of potassium with salt produces desirable results, undoubtedly due to the fact that it counteracts the effect of the sodium. A sufficient amount of salt for the day's ration should not be given a cow at one time, but should be mixed with the feed, to be of the greatest benefit. Other minerals should be ground very fine, and not fed in a concentrated form, but sprinkled over moist hays, silage, or grain feeds. Mr. Monroe, of the Ohio Agricultural Experiment Station, has found that a small quantity of lime sprinkled over the silage forms calcium lactate, which is desirable for milk production.

Even minerals in water seem to have a potent effect upon milk production, and the unsatisfactory results from experiments carried on with distilled water are due, I believe, in a large part to the lack of minerals in the water.

The effect of minerals in the dairy ration is not directly evident in the increased flow of milk. The improvement in the physical condition of the animal is more apparent and, due to this, the milk flow is eventually increased. Minerals also seem to have a very important effect upon the unborn calf, undoubtedly due to the improved physi-

cal condition of the mother. If judgment is used in feeding minerals the tendency is for the calves to be strong and vigorous.

To obtain the best results, the feeder must study his individual cow, and his ability to feed and care for that cow determines to a very great extent whether she will produce nearly her maximum amount over a period of years or her lifetime.

Chairman JEFFERS. We have a subject here which I think is big enough for two sessions and we are trying to crowd it into one.

The next will be a paper on "Factors influencing the vitamin content of cow's milk," by Prof. R. A. Dutcher, of the department of agricultural chemistry, Pennsylvania State College.

FACTORS INFLUENCING THE VITAMIN CONTENT OF COW'S MILK.

R. ADAMS DUTCHER, department of agricultural chemistry, Pennsylvania State College, State College, Pa.

Lunin (1), in 1881, made what was probably the first suggestion that milk contains substances other than proteins, fats, carbohydrates, salts and water which are indispensable for normal nutrition. This statement was based upon the fact that he was not able to rear experimental animals successfully on a ration containing apparently adequate amounts of proteins, fats, carbohydrates, and salts. Small additions of milk, however, caused these animals to develop in a normal manner. Little attention was paid to Lunin's suggestions, however, until 1906, when Hopkins (2) reported "that no animal can live upon a mixture of pure protein, fat and carbohydrate and even when the necessary inorganic material is carefully supplied, the animal still can not flourish. The animal body is adjusted to live either upon plant tissues or other animals, and these contain countless substances other than proteins, carbohydrates, and fats." In 1909, Stepp (3) reported that bread and milk was a satisfactory diet for rats. When, however, he extracted the mixture with alcohol and ether, the extracted residue would not longer support growth. Addition of the ether-alcohol extract stimulated growth when animals had failed to grow on the extracted residue. This work added further evidence to support the idea that milk contains unknown growth-promoting factors. Later, Hopkins (4) published data to show that 2 cubic centimeters of milk were sufficient to supply enough of the unknown growth-promoting materials for growth.

Since that time experimental data have accumulated until practically all nutrition authorities are agreed that an important part of the nutritive value of milk lies in the amount of the vitamins A, B, and C present at the time that the milk is ingested. It is now becoming quite evident that a fourth factor, the antirachitic vitamin, must be considered in all vitamin studies. Any information, therefore, that we can obtain concerning the factors which influence the vitamin content of milk will be of considerable value. The factors considered in this paper are (a) diet, (b) heat treatment, and (c) oxidation.

MILK VARIES IN VITAMIN CONTENT.

In 1920, Osborne and Mendel (5) published data to show that 2 cubic centimeters of fresh milk would not suffice for growth when fed as the only source of vitamin B, and, what was more interesting, rats did not grow normally until the amount of milk was increased to 16 cubic centimeters. Kennedy and Dutcher (6) made similar observations, with the exception that 10 cubic centimeters of milk carried sufficient vitamin B for growth. These and similar observations with reference to vitamins A and C, naturally raised the question in the minds of many investigators as to the factors causing the variability in the vitamin content of milk. The variations were particularly striking with regard to the antiscorbutic properties of milk. Chick, Hume, and Skelton (7), for example, reported that 85 cubic centimeters (daily) of milk were necessary for the protection of guinea pigs from scurvy, while other investigators reported prevention of scurvy in guinea pigs with amounts of milk varying from 50 to 130 cubic centimeters.

THE INFLUENCE OF DIET.

A number of investigators noted the variability in vitamin potency of cow's milk obtained from various sources and, although experimental proof was lacking, it seemed probable that the vitamin content of the diet might be an influencing factor. Funk (8) suggested this possibility as early as 1914. Previous to Funk's observation, Andrew (9) had reported that babies, nursed by mothers afflicted with beri-beri, also became afflicted with the disease. McCollum and his coworkers (10) arrived at similar conclusions while conducting feeding experiments with rats. As we (11) have pointed out in a previous paper, the evidence obtained by McCollum, with rats, was not conclusive due to the fact that he was unable to say with certainty that the nursing rats did not grow because of the vitamin deficiency of the mother's milk. He had no way of measuring the milk flow of the mother rats, and it was possible that the young were starved due to decreased milk flow.

In August, 1919, Dutcher, Pierson, and Biester (12) announced that they had noted a seasonal variation in the antiscorbutic potency of milk. A similar observation was made simultaneously by Barnes and Hume (13). In 1920, Hart, Steenbock, and Ellis (14) described experiments in which milk from the university herd was compared with milk obtained from cows which had been fed for a number of years on air-dried roughages and grains. These writers found that the milk from the latter herd was much inferior in antiscorbutic potency to the milk obtained from the university herd. During the same year Dutcher, Eckles, and coworkers (11) described experiments which differed from the Wisconsin work in that the experimental milk was obtained from the same cows, thereby eliminating any possibility of introducing variations due to differences in individuals.

In the last-mentioned study two cows were fed a vitamin-poor ration from January 17, 1920, until June 1, 1920. On June 1 the cows were given access to fresh pasture grass and continued on the ex-

perimental ration until October 1, 1920. During the vitamin-poor and vitamin-rich periods, groups of guinea pigs were placed on a basal ration of oats and varying quantities of the experimental milk. After feeding a relatively large number of guinea pigs for the eight months' feeding period it was concluded that 20 cubic centimeters of the "summer milk" was superior to 60 cubic centimeters of the "winter milk." It was found that there was a tendency for the milk to become poor slowly when the diet of the cows was deficient in vitamins, while the nutritive value of the milk became relatively high almost immediately after the cows were given access to green grass. In other words, it would seem that Mother Nature uses this method to protect the young by allowing the nursing mother to dole out her vitamins sparingly from her body tissues in order to keep the milk adequate. On the other hand, the milk becomes vitamin-rich rapidly after a change to a vitamin-rich diet. Simultaneously with the last-mentioned work, Hess, Unger, and Supplee (15) reported similar observations regarding milk powders made from milk obtained from cows fed in a similar manner. The milk powder, obtained when the cows were fed a vitamin-rich ration, was superior in antiscorbutic properties to milk obtained from the same cows during a vitamin-poor feeding period.

Previous to the publication of the last-mentioned articles, Osborne and Mendel (16) had announced that they were unable to find that summer milk was superior to winter milk as far as vitamin B was concerned. This can be explained on the basis that it is almost impossible, under ordinary conditions, to feed dairy cows a ration that is not fairly rich in this vitamin. It is reasonable to expect that milk could be produced which is practically devoid of vitamin B, provided a sufficiently poor ration be employed. Hughes, Fitch, and Cave (17) reported in 1921 that they were unable to demonstrate that the antiscorbutic potency of milk could be affected by diet although vitamins A and B were present in greater quantity when the cows were fed a vitamin-rich ration.

In 1922, Kennedy and Dutcher (18) announced the results of their work on the influence of diet upon the quantity of vitamins A and B in milk. It was concluded that the amount of vitamins A and B in milk are directly dependent upon the vitamin content of the dairy ration and that stall-fed cows will produce a vitamin-rich milk if fed the proper combination of grains, silage, and legume hay.

It is reasonable to believe that the principles established in the researches just reviewed will apply to the feeding of all lactating animals. Medical men have known for a great many years that, other things being equal, infants thrive best when the diet of the mother is adequate and varied.

THE EFFECT OF HEAT TREATMENT.

It is impossible in a paper of this type to include all of the work that has been done in this field. The speaker will be satisfied if he is able to outline the general trend of events and indicate some of the more important tentative conclusions that might be drawn.

As early as 1894 Barlow (19) was convinced that "cooked" milk was inferior to raw milk in antiscorbutic potency. Without at-

tempting to review the literature relating to the clinical observations made by physicians and nutrition workers, it will suffice to say that many practitioners contended that Pasteurized and "cooked" milk should be avoided, due to the fact that scurvy invariably developed. Other authorities, among whom the name of Lane-Claypon (20) is prominent, contended that the nutritive value of milk is not injured by heating.

Since the advent of the vitamin hypothesis considerable work has been done with the view of determining the stability of the various vitamins to heat. Hess and Fish (21) stated in 1914 that heat slowly destroyed the antiscorbutic properties of milk, but that an intense heat for a short period seemed to be less destructive than a lower temperature for a longer time. Barnes and Hume (22) reported that about half of the antiscorbutic potency was lost when milk was heated rapidly to the boiling point over a gas burner. Hart, Steenbock, and Smith (23) have shown that the antiscorbutic vitamin is destroyed when milk is heated at 120° C. for 10 minutes.

Miss Edla Anderson, working in the speaker's laboratory, has shown that Pasteurization of milk in closed bottles at 145° F. for 30 minutes does not destroy appreciable amounts of vitamin C. When this Pasteurized milk was fed to guinea pigs at 30 cubic centimeter levels as the source of vitamin C, there was little if any difference between the animals and those fed an equal quantity of raw milk. This agrees with the observations of French pediatricians (24), who report the feeding of thousands of babies on milk, Pasteurized in bottles, without a single case of scurvy. It has been our experience that, as a rule, 30 cubic centimeters of milk will protect 250-gram guinea pigs for periods of 90 to 120 days, providing the milk is reasonably rich in vitamin C. This being the case, we have adopted the practice, in our experimental work, of using 20, 30, and 40 cubic centimeters of milk in our scurvy studies; 20 cubic centimeters will not protect for long periods, while 40 cubic centimeters is ample if the milk is rich in vitamin C. It has been our experience that 30 cubic centimeters of milk represents the "threshold" quantity of vitamin C for scurvy studies. For that reason we have felt that any study involving the effect of heat or oxidation should include groups of animals receiving about that quantity of milk in addition to the basal ration. Any slight destruction will make itself evident when milk is fed at this level. We have also found it to be absolutely necessary that control animals be fed at the same time on equal quantities of untreated raw milk.

While the antiscorbutic vitamin is probably the most susceptible of all of the known vitamins to heat, nevertheless it would appear that the ordinary methods of vat Pasteurization as practiced in this country are less destructive than has been thought. We have fed guinea pigs Pasteurized milk that was made by the holding process (145° F. for 30 minutes) that compared quite favorably with the same milk before treatment. It is true that heat has a destructive action on vitamin C, but the advantages of Pasteurization more than counterbalance the disadvantages due to vitamin destruction. It should be remembered that milk is not considered a vitamin-C-rich food, and for that reason it is the practice of progressive physicians to prescribe orange juice or tomato juice for bottle-fed infants. In

this connection it should be emphasized, also, that milk is diluted in preparing the modified milk used in infant feeding. This often lowers the vitamin potency to the danger point.

While we are discussing the vitamin content of milk from the standpoint of infant feeding, it should be pointed out that the recent work of McCollum and coworkers at Johns Hopkins University has shown quite conclusively that cod-liver oil contains two vitamins, vitamin A and an antirachitic factor. It has been known for some time that rickets is most prevalent in bottle-fed infants, indicating that milk is not particularly rich in the antirachitic substance. For that reason, prominent pediatricians (25) are recommending the feeding of cod-liver oil as well as orange juice to bottle-fed normal healthy infants.

When we consider the question of the destruction of vitamin A, in which milk is relatively rich, we find practically no data concerning the destruction of this vitamin in the heating of milk. Osborne and Mendel (26) passed live steam through butterfat for two and one-half hours. Rats grew well on a ration containing 18 per cent of this heated butterfat. These authors concluded, therefore, that vitamin A was stable to heat at the temperature of steam.

Later, Steenbock, Boutwell, and Kent (27) showed that butter kept at 100° C. and stirred by a stream of air for 12 hours would not produce good growth. In 1920, Osborne and Mendel (28) published data confirming their previous work. It soon became evident that oxidation was playing a part in the destruction of vitamins by heat.

OXIDATION.

In 1919, Zilva (29), in working with ultra-violet rays, noted the destruction of vitamin A in butter when the butter was exposed to the rays for several hours. He noted the presence of ozone, and further experimentation (30) brought to light the fact that the destruction of vitamin A was due to oxidation. He also was able to destroy this vitamin in cod-liver oil, although it required more severe treatment due to the high concentration of the vitamin in cod-liver oil. In 1920, Hopkins (31) and Drummond and Coward (32) announced the destruction of vitamin A in butterfat by atmospheric oxidation.

The following year Drummond, Coward, and Watson (33) published the results of their work on milk and butter and showed that colostrum was richer in vitamin A than the later milk. They reported a loss of vitamin A in butter manufacture, due in all probability to the fact that a portion of this vitamin is in the milk serum. They also emphasized the importance of the diet of the cow with regard to the vitamin content of the butter.

While conclusive evidence is lacking, it would appear that there is little to fear in the Pasteurization or boiling of milk, so far as vitamin A is concerned, for the vitamin appears to be stable to heat up to 100° C., and the opportunity for excessive oxidation in ordinary milk treatment is not great.

There is little evidence that ordinary methods of Pasteurization or boiling have a destructive action on vitamin B. In fact it would appear that this vitamin is relatively stable to temperatures up to

100° C. Daniels and Loughlin (34) have shown that the nutritive value of milk is impaired by heating, but that the loss of nutritive value is due to the loss of calcium and phosphorus salts rather than a vitamin destruction. Mr. J. R. Haag, working in my laboratory, has fed rats a diet consisting solely of raw and Pasteurized milk, but has been unable to find that the milks differed in nutritive value.

McCollum oxidized cod-liver oil by bubbling air through the oil at 100° C. and was able to destroy vitamin A, but the antirachitic factor was unimpaired. It is evident, therefore, that the antirachitic vitamin is stable to heat and oxidation. Little is known, however, at the present time, regarding the distribution of this vitamin in other foodstuffs.

When we consider the effect of oxidation on the antiscorbutic vitamin, we find that we are dealing with a less stable substance. Hess (35) showed in 1920 that milk lost some of its antiscorbutic properties when shaken with air. Miss Anderson, working in my laboratory, observed (36) that vitamin C was destroyed when milk was violently agitated in an open dish during Pasteurization, while the same milk Pasteurized in closed bottles compared favorably with the untreated milk. When air was bubbled through the milk during Pasteurization some destruction occurred, but the destruction was small compared to that obtained when oxygen was used instead of air. Oxygen and hydrogen peroxide destroyed this vitamin at room temperature, although the destruction took place more rapidly on heating. When milk was agitated with a stream of carbon dioxide during Pasteurization, there was little if any destruction of vitamin C.

While it is not within the province of this paper to discuss the vitamin content of powdered milks, it is of interest to note that many of the commercial milk powders made by the spray process (37) have been found to be deficient in vitamin C, while powders made by the roller process seem to be somewhat superior (38).

Experiments just recently terminated at Cornell University indicate that the present methods of making sprayed whole-milk powder as now in use at the Perry, N. Y., plant of the Merrell-Soule Co., do not destroy the antiscorbutic potency of the milk. In these experiments raw whole milk and milk powder were shipped daily from the plant to the university. The powdered milk was made to the same concentration as the raw milk by the addition of water, and the milks were compared, using guinea pigs as the experimental animals. The results show no differences between the raw and the powdered milks. This is explained by the fact that the milk is condensed in vacuum, and the condensed milk is Pasteurized without agitation in a closed container in the absence of air. This milk is then sprayed at an enormous pressure into a "hot room," and the atomized particles are dried instantly and removed in a relatively short time. It would appear, therefore, that it is possible to make sprayed milk powder without destroying vitamin C, and that the spraying operation does not of itself destroy this vitamin, provided the process is properly regulated.

As I have pointed out in a previous article (39), "even if it were proven, eventually, that condensed milks and milk powders were devoid of vitamins—which I doubt—there would still be a very im-

portant place for these products in the diet when supplemented properly by other foods. It would be just as inadvisable to make sweeping condemnations of these important commodities as to condemn white corn as a food because it appeared to be somewhat inferior to yellow corn. What we should try to do is to get at the facts, prove conclusively that they are facts, and then take steps to improve methods of manufacture and to supplement our deficient foods with those which are known to be rich in vitamins."

While milk is the most valuable single article of food that we have, let us recognize that it is not, as many would try to make us believe, a perfect food. In spite of the fact that I have pointed out certain deficiencies that may occur in milk, let us not forget that we should do all in our power to make the public appreciate that there is no food that can take the place of milk, and that increased consumption of milk, supplemented with other foods, should be encouraged.

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Chairman JEFFERS. The hour for closing is approaching. Those papers whose authors are absent will be read by title.

(Adjournment.)

(Papers read by title):

CONTRIBUTION À L'ÉTUDE DES VARIATIONS DE LA COMPOSITION DU LAIT.

E. HUYNEN, professeur à l'Ecole de Médecine Vétérinaire, Bruxelles.

Le lait (il s'agit du lait de vache n'ayant subi aucune manipulation frauduleuse et provenant de laitières parfaitement saines, bien nourries et traitées rationnellement) n'est pas toujours identique à lui-même. Sa composition présente des variations fréquentes et importantes qui sont dues à l'influence d'une série de facteurs agissant tantôt isolément, tantôt concomitamment.

Certains de ces facteurs, dont l'action est bien connue et d'ailleurs assez constante, sont étudiés avec tous les détails nécessaires par les auteurs qui se sont occupés de la composition chimique du lait et des influences modificatrices de cette dernière. Il en est ainsi notamment de l'influence des diverses phases de la vie sexuelle, de la castration, des races et des individus.

Mais ces facteurs ne nous permettent pas d'expliquer toutes les variations observées. Nous devons bien admettre que certaines influences nous échappent et que nous n'entrevoyons même pas, dans certains cas, la nature des causes qui déterminent les modifications constatées.

Nous avons pensé qu'en notant nettement celles-ci nous contribuerions à l'étude de leur interprétation. C'est ce que nous faisons dans les pages qui vont suivre dans lesquelles nous résumons les résultats de nombreuses observations que nous avons faites dans des conditions bien déterminées et souvent imposées par nous-même.

Nous savons que certains chiffres indiqués dans ce travail étonneront plus d'un lecteur; il en sera certainement ainsi pour les cas où la teneur en matières grasses est très basse et notamment inférieure au minimum prescrit par certaine décision ministérielle arrêtée pendant la guerre en Belgique.

Jusqu'ici on ne s'est guère occupé dans l'étude des variations de la composition du lait que de celles qui portent sur la teneur en matières grasses. Il est cependant bien intéressant de contrôler également celles des autres constituants. On a considéré trop long-

temps la graisse comme la seule substance importante du lait et on s'est basé sur son pourcentage pour déterminer la valeur du lait, ce qui est parfaitement logique lorsqu'il s'agit exclusivement de la fabrication du beurre et quand le lait écrémé ne constitue qu'un résidu, mais il n'en va plus de même quand le lait est consommé en nature ou quand il est utilisé pour la fabrication de fromage ou d'autres dérivés que le beurre.

Le lait est avant tout un aliment complet, contenant, à côté de la graisse, des substances azotées, des sels, du lactose, des diastases et des vitamines. Nous faisons ici abstraction des deux derniers groupes. Mais les substances azotées, les sels, notamment les sels de chaux et le lactose ont des rôles très importants à remplir: les matières azotées sont indispensables à l'édification et à la reconstitution des tissus, les sels de chaux sont les facteurs essentiels de la fabrication du tissu osseux, le lactose opère la désinfection intestinale d'une façon permanente et régularise plus d'une fonction, etc. Tous ces rôles sont certainement aussi importants que celui de la graisse, et il y a lieu d'en tenir compte pour apprécier la valeur du lait. C'est pourquoi nous avons noté, à côté des variations de la graisse, celles de l'extrait sec dégraissé, c'est-à-dire de l'ensemble des matières fixes du lait, moins la graisse.

D'une façon générale la densité du lait est directement proportionnelle à la quantité de substances dissoutes ou en suspension et indirectement proportionnelle à la richesse en graisse. Celle-ci étant plus légère que l'eau abaisse d'autant plus le poids spécifique du lait que celui-ci est plus butyreux.

Connaissant le poids spécifique des unes et de l'autre on peut, en se basant sur la teneur en graisse et sur la densité, établir par le calcul la quantité de substances, autres que la graisse, contenues dans le lait. Ces calculs ont permis d'établir plusieurs formules, parmi lesquelles celle de Fleischman est surtout utilisée. C'est celle que nous avons employée pour établir nos diagrammes.

Il est certain que l'extrait rigoureusement précis ne peut être obtenu que par l'évaporation de l'eau contenue dans le lait; mais la formule de Fleischman fournit des données très approximativement exactes quand il s'agit de laits non falsifiés, ce qui fut le cas dans nos observations.

Pour permettre au lecteur de juger rapidement de l'importance des variations constatées nous donnons ci-après quelques moyennes généralement admises pour la composition du lait normal:

	Hollande.	France.	Danemark et Suisse.
Densité.....	1,029.8 <i>Pour cent.</i>	1,032.5 <i>Pour cent.</i>	1,033 <i>Pour cent.</i>
Matières grasses.....	3.65	4.2	4.4
Extrait sec dégraissé.....	8.43	9.21	9.38

Comme on le voit la race joue un rôle très important.

Tous les auteurs établissent une composition moyenne du lait et signalent qu'elle subit des variations assez marquées.

Dans son cours d'analyse physico-chimique du lait, M. Vanden Eeckhout rapporte qu'avant la guerre le lait de mélange présentait dans la banlieue de Bruxelles, où l'on exploitait beaucoup le bétail

hollandais, les caractères analytiques suivants: Densité à 15° C., 1,030; matières grasses, 3.2 pour cent; extrait sec dégraissé, 8.5 pour cent.

Les diagrammes joints au présent travail donnent la composition journalière moyenne du lait de mélange de 250 vaches environ exploitées dans les environs de Bruxelles, bien nourries et placées dans de bonnes conditions hygiéniques.

Les moyennes générales annuelles ont été:

	En 1921.	En 1922.
Densité.....	1,031.17 <i>Pour cent.</i>	1,031.3 <i>Pour cent.</i>
Matières grasses.....	3.35	3.21
Extrait sec dégraissé.....	8.712	8.715

Les maximums et les minimums obtenus furent:

	En 1921.		En 1922.	
	Maximum.	Minimum.	Maximum.	Minimum.
Densité.....	1,032.8 <i>Pour cent.</i>	1,028.8 <i>Pour cent.</i>	1,033.8 <i>Pour cent.</i>	1,030 <i>Pour cent.</i>
Matières grasses.....	4	2.95	3.9	2.7
Extrait sec dégraissé.....	9.17	8.11	9.18	8.36

En 1921 le troupeau comprenait 80 pour cent de vaches indigènes et 20 pour cent de vaches hollandaises, tandis qu'en 1922 le pourcentage en hollandaises a atteint 30, ce qui explique la légère diminution de la teneur en matières grasses du lait de mélange.

Comme nous le disions plus haut, les variations dues aux races présentent un intérêt spécial qui est surtout important pour les producteurs de beurre.

Dans l'étude suivante nous faisons abstraction de cette question parce que nos observations ont porté sur un troupeau très varié. Il en est d'ailleurs de même autour de la plupart des grandes agglomérations où le lait produit est principalement destiné à être vendu en nature.

Dans ces conditions les laitiers n'ayant en vue que la production d'une grande quantité de lait ne se soucient guère de sa richesse en graisse et s'adressent surtout aux vaches grandes laitières et conséquemment avant tout à la race hollandaise réputée, à juste titre d'ailleurs, comme étant la plus forte productrice de lait du monde.

Il en résulte que le lait produit par les laiteries, dans les environs des grands centres surtout, est moins riche que celui des fermes dans lesquelles on exploite principalement le bétail indigène qui donne un lait ayant une teneur en matières fixes sensiblement plus élevée.

Ce fait présente une importance spéciale pour les experts chargés du contrôle du lait. Ils ne peuvent pas prendre comme base la composition moyenne du lait produit par le bétail d'un pays pour juger un échantillon, même produit dans ce pays et soumis à leur examen. Leur devoir est de remonter à l'origine de ce lait, à la vache productrice et nous verrons plus loin que là le rôle de l'expert est loin d'être aussi facile qu'on pourrait se le figurer.

VARIATIONS GÉNÉRALES.

Nous entendons par variations générales celles qui intéressent la composition du lait de mélange de tout un troupeau et qui sont dues par conséquent à des facteurs d'ordre général.

Parmi elles nous étudierons les variations journalières et les variations saisonnières.

VARIATIONS GÉNÉRALES JOURNALIÈRES.

Ce sont certainement celles qui surprennent le plus l'observateur à ses débuts.

Il semble que, tout au moins, le lait de mélange d'un troupeau important devrait avoir sensiblement la même composition tous les jours. Il n'en est rien. Les variations du jour au lendemain sont parfois très importantes. On peut rapidement s'en rendre compte en examinant les deux premiers diagrammes ci-joints qui donnent la composition moyenne du lait de mélange de 250 vaches de tous les jours des années 1921 et 1922.

Il est facile de constater que la teneur en graisse est plus variable que celle des autres substances fixes.

Examinant, par exemple, les modifications de la teneur en matières grasses pendant le mois d'avril 1921 nous constatons que le 5 et le 6 de ce mois l'analyse accuse 37 par mille¹ de graisse; le 7 cette quantité devient 34 par mille, descend à 32.5 par mille le 8, pour revenir à 33.5 par mille le 9 et monter à 38 par mille le 10. Neuf jours après, le 19, elle redescend à 31.5 par mille pour atteindre à nouveau la moyenne mensuelle de 34 par mille le 21.

Des variations de la même importance s'observent en juillet, en septembre et en octobre de la même année et pendant les mois d'avril, de mai, de juin et de juillet 1922. On peut, en jetant un coup d'œil d'ensemble sur les diagrammes, constater que les écarts inter-journaliers sont surtout prononcés pendant les mois où la teneur en graisse atteint son maximum ou son minimum tandis qu'ils sont moins brusques lorsque la richesse en graisse se rapproche de la moyenne.

La densité ne présente pas des fluctuations inter-journalières aussi conséquentes que la graisse et elle semble plus fixe pendant les mois où les variations de la matière grasse sont surtout importantes.

Les causes de ces variations journalières nous sont complètement inconnues. L'examen le plus méticuleux ne parvient le plus souvent pas à relever la moindre différence dans les conditions qui entourent l'exploitation alors que les fluctuations sont parfois très marquées.

VARIATIONS GÉNÉRALES SAISONNIÈRES.

D'après M. Monvoisin le lait subit au cours de l'année des variations de composition importantes, qualifiées de saisonnières au sujet desquelles les auteurs ne sont pas d'accord. D'après M. Monvoisin on admet généralement que le lait est plus riche en matières grasses au printemps et plus pauvre à l'automne. Certains auteurs ont constaté que le lait est plus riche à la fin de la saison estivale tandis

¹ Trente-sept par mille, soit 3.7 pour cent.

que d'autres, parmi lesquels MM. Eckles et Brioux trouvent un minimum de graisse au début de l'été et un maximum au début de l'hiver. M. Kort a constaté un maximum en janvier-février et un minimum en juillet-août.

Nos observations se rapprochent de celles de ces derniers auteurs. Elles ont été faites sur le troupeau précité (voir les deux premiers diagrammes).

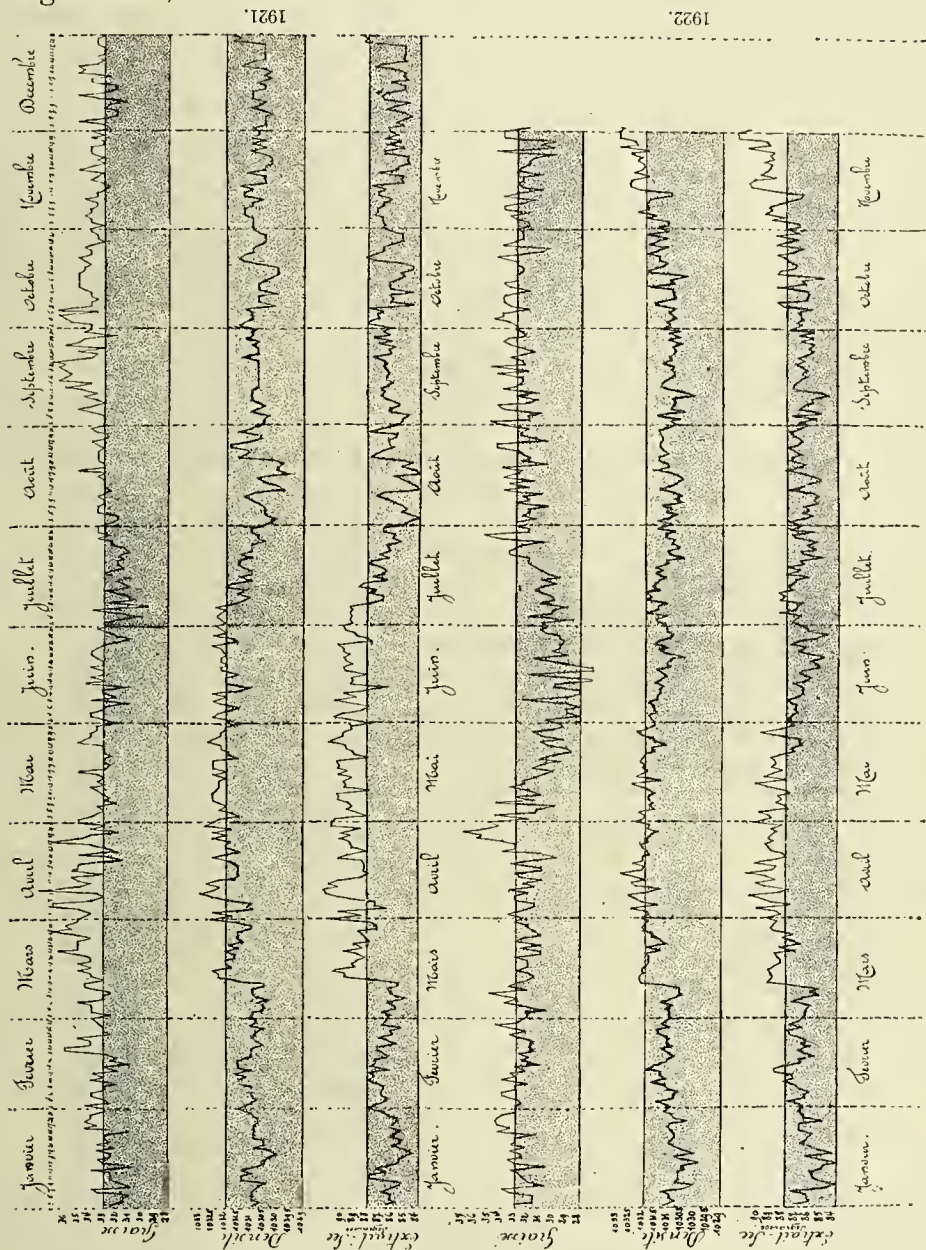


FIG. 1.—Variations journalières et saisonnières de la composition du lait, en 1921 et 1922.

Dans les deux graphiques qui suivent nous montrons les moyennes mensuelles. Le premier indique les variations saisonnières de la graisse, le second celles de l'extrait sec dégraissé.

(a) *Fluctuations saisonnières de la graisse.*—Il suffit de jeter un regard sur les diagrammes pour constater immédiatement que la richesse en matières grasses est à son minimum vers le commence-

ment de l'été, c'est-à-dire au mois de juillet en 1921 et au mois de juin en 1922.

A ce moment la graisse descend en 1921 à 29.5 par mille et en 1922 à 27 par mille.

Ce minimum ne persiste que quelques jours après lesquels la teneur en matières grasses augmente insensiblement tout en subissant les fluctuations journalières sus-indiquées pour atteindre un maximum deux ou trois mois après, c'est-à-dire vers septembre. En 1921 ce maximum se montre en septembre-octobre, tandis qu'en 1922 il est atteint un mois plus tôt. A remarquer également qu'en 1921 ce maximum est plus élevé qu'en 1922 (38 par mille contre 34 par mille.)

Après le mois d'octobre le pourcentage en matières grasses diminue légèrement jusqu'en décembre pour rester ensuite à peu près stationnaire jusqu'aux mois de mars ou avril. A ce moment la richesse du lait atteint un deuxième maximum plus élevé que celui de la fin de l'été, mais aussi de plus courte durée. Après ce nouveau maximum, qui se montre en avril, la teneur en graisse descend vers le minimum de juin-juillet qui nous a servi de départ plus haut.

En résumé, le lait est le plus riche en graisse au début du printemps et au début de l'automne, tandis qu'il est le plus pauvre au commencement de l'été.

Teneur mensuelle moyenne en matières grasses du lait de mélange de 250 vaches environ pendant les deux années 1921 et 1922:

	1921.	Par mille.
_____	Janvier.....	32. 77
_____	Février.....	33. 32
_____	Mars.....	34. 56
_____	Avril.....	34. 66
_____	Mai.....	33. 42
_____	Juin.....	33. 01
_____	Juillet.....	32. 10
_____	Août.....	33. 06
_____	Septembre.....	34. 54
_____	Octobre.....	34. 82
_____	Novembre.....	33. 27
_____	Décembre.....	33. 27
	1922.	
_____	Janvier.....	32. 84
_____	Février.....	32. 50
_____	Mars.....	32. 20
_____	Avril.....	33. 50
_____	Mai.....	31. 20
_____	Juin.....	29. 50
_____	Juillet.....	31. 40
_____	Août.....	32. 30
_____	Septembre.....	33. 10
_____	Octobre.....	32. 80
_____	Novembre.....	32. 60

En réunissant les sommets des lignes fortes on obtient une courbe montrant très bien les fluctuations.

Les fluctuations que nous venons de décrire se reproduisent tous les ans avec de très légères variantes. Nous avons pu suivre le lait de plusieurs vacheries pendant cinq ans et nous avons chaque année retrouvé les mêmes fluctuations aux mêmes saisons. Ces variations saisonnières sont donc régulières.

Nous avons remarqué que les extrêmes sont plus écartés quand les saisons sont bien marquées.

Il serait évidemment intéressant et utile de connaître les causes de ces fluctuations.

Une circonstance très importante est l'époque des vêlages.

A ce point de vue nous ferons remarquer que dans le troupeau sur lequel nos observations ont été faites nous avons, afin d'avoir à toute saison à peu près la même quantité de lait, cherché à échelonner les vêlages tout le long de l'année. Force nous est toutefois de reconnaître que malgré tous nos efforts dans ce sens nous avons toujours eu un plus grand nombre de parturitions vers la fin de l'hiver. En 1922, la répartition fut cependant assez satisfaisante, de nouvelles vaches, fraîchement vêlées ayant été introduites dans le troupeau à différents moments. Ce renouvellement du troupeau fut nécessaire à cause d'un changement apporté dans le mode d'exploitation.

En effet, l'élevage ayant été abandonné il a fallu remplacer les laitières dès que leur rendement devenait économiquement insuffisant. Cette modification, ayant comme conséquence la présence en permanence de vaches fraîchement vêlées, n'a pas empêché les variations saisonnières de se produire.

Nous avons cherché à déterminer l'influence de la gravidité sur ces variations.

Le résultat de nos recherches sur ce point est que la gravidité ne modifie guère les variations saisonnières de la teneur en matières grasses. Il n'en est pas de même en ce qui concerne l'extrait sec dégraissé, ainsi que nous le verrons plus loin.

Certains auteurs signalent toutefois que chez les vaches qui vêlent en automne la richesse butyreuse du lait reste sensiblement constante pendant toute l'année. Les observations faites sur ce point par nous ne sont pas assez nombreuses pour que nous puissions en tirer une conclusion. Ce n'est que dans un an que nos recherches sur ce point seront concluantes.

Beaucoup pensent que l'abondance de l'herbe au printemps, l'épuisement des pâtures vers la fin de l'été et l'administration d'aliments concentrés donnés en supplément peuvent expliquer toutes ces variations.

Pendant les années 1918, 1919 et 1920 nous avons pu suivre la composition du lait sur un troupeau de 60 à 80 vaches tenues en stabulation permanente. L'alimentation consistait pendant l'hiver en betteraves, son, tourteaux et foin. Durant l'été les betteraves étaient remplacées par des cossettes ou du trèfle vert.

Les variations signalées furent les mêmes chez ce bétail et chez celui qui passait la bonne saison au pâturage.

(b) *Fluctuations saisonnières de l'extrait sec dégraissé.*—Lorsqu'on examine les deux premiers diagrammes il semble à première vue que les variations de l'extrait sec sont analogues à celles de la graisse en ce sens qu'à certaines saisons la teneur est élevée tandis qu'à d'autres elle est basse.

Toutefois une distinction doit être bien établie ici et consiste à considérer d'une part les vaches pleines et d'autre part celles qui ne le sont pas.

En 1921 toutes les vaches ont été remises au taureau, tandis qu'en 1922 la plus grande partie n'a pas été saillie pour la raison présignalée.

En 1921 les résultats de notre exploitation peuvent être assimilés à ceux de la plupart des exploitations dans lesquelles les vèlages se produisent, surtout à la sortie de l'hiver, et dans ces conditions nous constatons que la teneur en extrait sec dégraissé atteint et conserve son maximum pendant les mois de mars, avril, mai et juin; à partir de ce moment le pourcentage diminue pour ne remonter sensiblement qu'au mois de mars de l'année suivante.

Deux périodes attirent principalement l'attention: le mois de juillet et le mois de mars. Le premier répond au moment des saillies, ou plus exactement un mois après, c'est-à-dire au moment où le développement du fœtus devient conséquent. Le second correspond au moment des vèlages. Depuis mars jusqu'en juillet les vaches sont vides et l'extrait est très élevé; tandis que de juillet au mois de mars suivant l'extrait est plus faible et pendant cette même période le fœtus se développe.

Avant de conclure examinons cependant ce qui se passe pendant l'année 1922, au cours de laquelle, comme nous l'avons dit, l'élevage fut abandonné et quelques vaches seulement furent remise au taureau. L'extrait sec, élevé au printemps, subit une légère chute au début de l'été mais remonte rapidement pour conserver un niveau nettement supérieur à celui de l'année précédente.

Teneur mensuelle moyenne en extrait dégraissé du mélange de 250 vaches environ pendant les années 1921 et 1922:

	1921.	Par mille.
_____	Janvier.....	86. 00
_____	Février.....	86. 60
_____	Mars.....	87. 90
_____	Avril.....	88. 93
_____	Mai.....	88. 61
_____	Juin.....	88. 42
_____	Juillet.....	87. 20
_____	Août.....	85. 90
_____	Septembre.....	86. 54
_____	Octobre.....	86. 64
_____	Novembre.....	85. 97
_____	Décembre.....	85. 83
	1922.	
_____	Janvier.....	85. 85
_____	Février.....	87. 00
_____	Mars.....	87. 75
_____	Avril.....	89. 10
_____	Mai.....	88. 50
_____	Juin.....	86. 75
_____	Juillet.....	87. 00
_____	Août.....	87. 10
_____	Septembre.....	86. 70
_____	Octobre.....	87. 50
_____	Novembre.....	89. 10

Nous admettons donc que la gravidité exerce une action manifeste sur la teneur en extrait sec du lait. Les vaches pleines donnent un lait plus pauvre en substances fixes autres que la graisse.

Comme conclusion générale de notre étude des variations saisonnières nous dirons que le lait a son maximum de valeur, toutes con-

ditions restant ce qu'elles sont dans une exploitation normale, depuis mars jusqu'en juin. Le minimum de valeur se recontre vers juin-juillet.

INFLUENCE DU NOMBRE ET DES HEURES DES TRAITES—FAUT-IL TRAIRE DEUX OU TROIS FOIS?

Il est de règle, en Belgique tout au moins, de pratiquer journellement trois traites: le matin, le midi et le soir, et il n'est pas toujours procédé à ces opérations à des heures bien régulières.

La traite du matin se fait en été vers 4 ou 5 heures, tandis qu'en hiver elle est souvent retardée jusque vers 6 et même parfois 7 heures. Celle du soir est généralement exécutée vers 6 heures en été et vers 5 heures en hiver. La traite de midi est faite vers 11 heures. Il en résulte que les écarts entre les diverses traites sont loin d'être les mêmes. Entre la traite du matin et celle du midi il y a un écart de 5 à 6 heures; entre celles du midi et du soir il y a 6 à 7 heures, tandis qu'entre cette dernière et celle du lendemain matin s'écoule un laps de temps de 10 à 12 heures.

De nombreuses mensurations effectuées nous permettent de dire que, lorsque les traites sont faites dans ces conditions, celle du matin fournit 45 pour cent du rendement journalier, celle du midi 25 pour cent et celle du soir 30 pour cent. La quantité de lait par traite est donc en rapport avec l'écart qui sépare cette traite de la précédente.

L'on constate d'autre part une composition très différente du lait de ces trois traites. Les variations portent surtout sur la teneur en graisse. Pour le moment nous n'envisageons que celle-là.

Le lait du matin, le plus pauvre des trois, donne ± 28 par mille² de graisse; celui du soir ± 35 par mille tandis que celui du midi, le plus riche, atteint ± 40 par mille.

En rapprochant ces richesses butyriques des écarts entre les diverses traites, on voit que la proportion de la graisse est d'autant plus élevée que le lait provient d'une traite qui suit la précédente à plus court intervalle. Aussi a-t-on conclu à un rapport de cause à effet entre ces deux constatations.

Si les choses se passent ainsi, le fait d'éloigner une traite de la précédente doit avoir comme conséquence de diminuer proportionnellement sa teneur en graisse; en particulier, la suppression de la traite du midi doit appauvrir le lait du soir et, si l'interprétation que nous venons de signaler est exacte, comme de ce fait l'écart entre la traite du matin et celle du soir devient le même que celui qui sépare celle du soir de celle du lendemain matin, la richesse du lait du soir doit devenir la même que celle du lait du matin.

Or, comme nous le verrons, c'est l'inverse qui se produit et si, incontestablement, l'écart entre deux traites a comme effet d'influencer, dans certaines conditions, la qualité du lait, il est indiqué de chercher l'influence d'autres facteurs pour expliquer les variations constatées.

En Hollande depuis longtemps on a, dans beaucoup d'exploitations, afin de diminuer la main-d'œuvre, supprimé la traite de midi, généralement peu productive d'ailleurs. Dans certaines régions belges on a aussi adopté, mais timidement, le régime des deux traites

² Vingt-huit par mille, soit 2.8 pour cent.

depuis la pénurie de la main-d'œuvre et l'instauration de la journée de huit heures.

Nous avons été amené à supprimer la traite du midi pour d'autres raisons et les résultats obtenus nous paraissent mériter d'être rapportés.

La vacherie-laiterie de K—— a un effectif de 26 vaches laitières dont 40 pour cent de hollandaises. Lors du régime des trois traites le lait de mélange de la traite du matin accusait souvent une teneur en graisse inférieure à 28 par mille. Le lait du midi donnait 40 par mille; celui du soir 35 par mille.

Le lait provenant de ce troupeau étant livré cru, il faut le fournir le plus rapidement possible après la traite et en lui faisant subir le moins de manipulations possible, tel le mélange des diverses traites, opération faite en vue de l'obtention d'un produit de composition sensiblement constante.

La livraison du lait du matin exposait à des contraventions résultant de ce fait que beaucoup de chimistes considèrent encore comme écrémé le lait qui n'accuse pas 28 par mille de graisse. Nous avons donc cherché à modifier cet état de choses.

Depuis plusieurs années nous avions supprimé la traite de midi pour les vaches ayant un rendement journalier inférieur à 10 litres et nous avions observé que le lait du matin devenait plus riche en graisse. Au début nous n'avons attaché que peu d'importance à cette constatation, attribuant l'augmentation de la teneur en beurre au fait que les vaches ainsi traitées approchaient la fin de leur période de lactation et c'est un fait classique qu'à ce moment le lait devient plus butyrique.

En présence de la situation présignalée et de la constatation dont il vient d'être question, nous avons instauré le 9 février 1922 le régime des deux traites pour toutes les vaches de la laiterie de K——. Les résultats obtenus sont consignés sur le diagramme ci-contre qui donne la teneur en graisse et en extrait sec dégraissé du lait du matin et du soir de tous les jours de l'année 1922. En l'examinant on constate que la teneur en graisse a changé le matin et le soir. Les deux traites ont lieu à 5 hrs. 30 le matin et à 5 hrs. 30 le soir. Elles sont donc équidistantes et se font toujours dans le même ordre, c'est-à-dire qu'elles débutent et finissent toujours par les mêmes vaches.

Examinons successivement les modifications qualitatives et les modifications quantitatives du lait.

MODIFICATIONS QUALITATIVES.

(a) *Du lait du matin.*—Du 1^{er} janvier au 9 février; c'est-à-dire pendant le régime des trois traites, la richesse butyrique du lait de mélange va de 25.5 par mille à 30 par mille avec une moyenne de 27 par mille pour les 39 jours. Pendant cette même période le lait du midi, dont il n'est pas fait mention dans le diagramme, accusait 40 par mille de graisse. Pour éviter les inconvénients signalés plus haut, le lait du matin était mélangé avec celui de la traite du midi de la veille. Mais c'est là une opération qu'il faut pouvoir éviter. Le lait de mélange ainsi obtenu atteignait en moyenne 33 par mille de graisse.

Le 9 février la traite du midi est supprimée et dès le lendemain la teneur en graisse monte; le 10 elle est de 30.5 par mille; le 11, 32 par mille; le 12, 34.5 par mille et ensuite elle se maintient entre 29 par mille et 38 par mille avec une moyenne de 34 par mille.

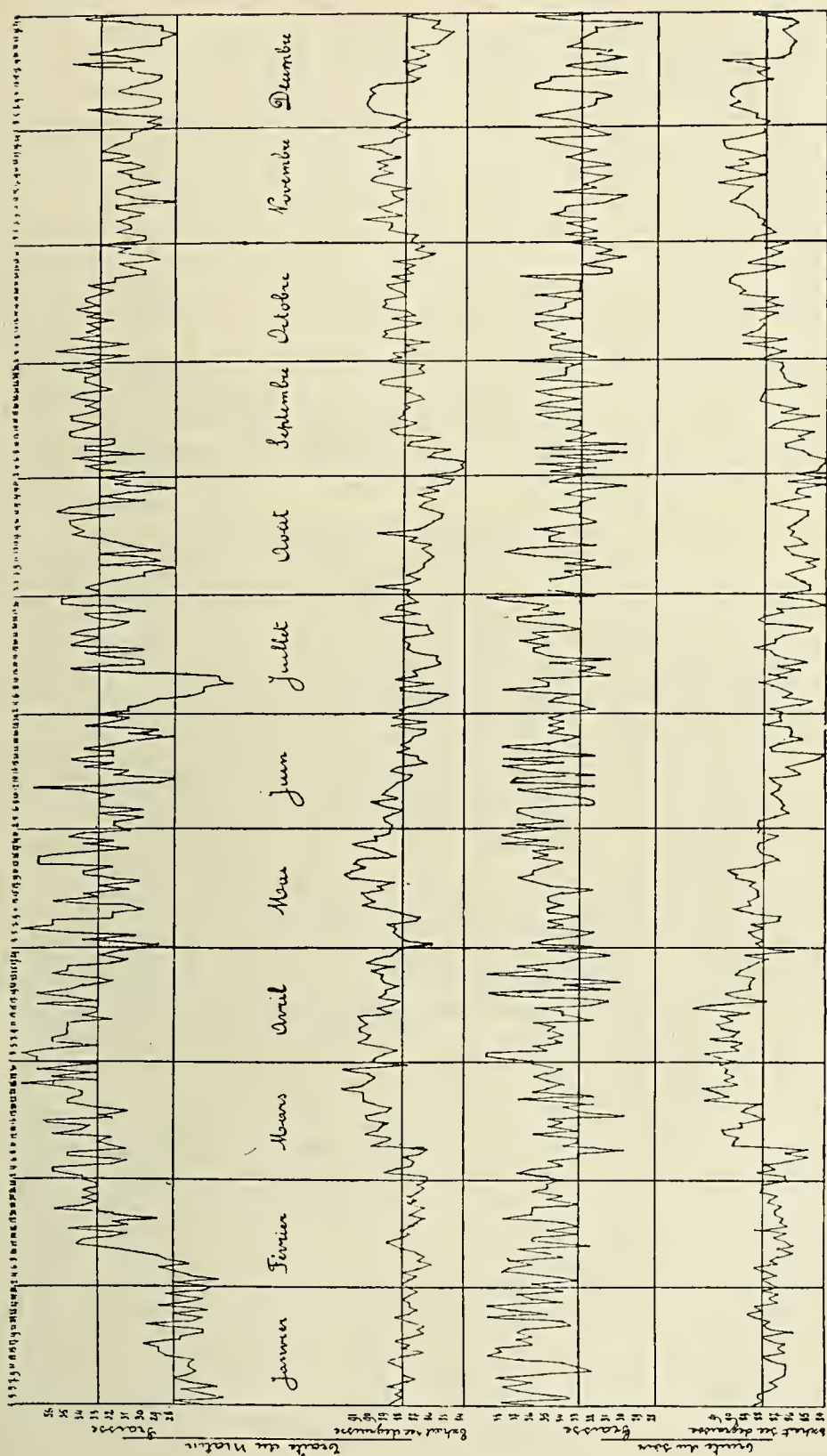


Fig. 2.—Variations journalières et saisonnières de la composition du lait pendant les deux et les trois traites. (1922.)

Le résultat visé était donc obtenu. Toutefois, à titre purement expérimental, nous avons rétabli le système des trois traites du 4 au 11 juillet et dès le 5 juillet la teneur butyrique du lait du matin descend pour atteindre 26 par mille le 7 et le 8 et même 24 par mille le 9. Le 11 le régime des deux traites est définitivement repris et le diagramme montre mieux que des chiffres le niveau atteint et conservé.

La densité du lait du matin est légèrement supérieure lors du régime des trois traites de même que l'extrait sec dégraissé.

(b) *Du lait du soir.*—La richesse butyrique du lait du soir s'abaisse légèrement dans le système des deux traites; de 35 à 37 par mille elle descend à 33.5 à 34 par mille. Cette modification est très facile à observer sur le diagramme à la période du 4 au 11 juillet pendant laquelle le bétail était soumis aux trois traites.

Outre ces modifications on peut constater que les variations inter-journalières que nous avons signalées dans la première partie de ce travail pour le lait de mélange des trois traites persistent.

On peut toutefois remarquer que les variations saisonnières sont moins bien marquées.

MODIFICATIONS QUANTITATIVES.

Tous les auteurs disent que trois traites donnent plus de lait que deux.

Nous avons pu vérifier ce fait qui est exact si on n'envisage que la quantité de lait et son extrait sec dégraissé.

Le système des deux traites provoque une diminution quantitative qui est proportionnelle au rendement et qui va de 1 pour cent chez les vaches qui donnent moins de 10 litres par jour pour atteindre 10 pour cent chez celles dont le rendement journalier est très élevé, 30 litres et plus.

La diminution de la quantité de lait d'un troupeau est en moyenne de 6 à 7 pour cent.

La quantité de graisse fournie par le bétail soumis au régime des deux traites ne suit pas cette même modification.

Nos expériences nous ont montré en effet qu'elle est sensiblement constante quelque soit le nombre de traites. Dans certains cas, rares d'ailleurs, nous avons constaté pour les mêmes vaches, une diminution de 1 à 1.5 pour cent de la quantité totale de graisse éliminée au détriment du régime des deux traites. Dans d'autres cas nous avons constaté le contraire.

Nous avons d'autre part soumis des vaches à la traite horaire, à la traite au bout de deux ou de trois heures et avons chaque fois observé que la quantité de graisse fournie est sensiblement constante.

Il est bon de remarquer que, lors de l'institution de traites multiples, on relève généralement, le premier jour du nouveau régime, une augmentation sensible de la quantité et de la richesse du lait. Mais le deuxième ou le troisième jour ce changement, que l'on voyait apparaître avec plaisir, cesse et au bout de quatre à cinq jours le rendement est inférieur à celui obtenu par le régime des trois traites.

Lors de traites multiples, horaires ou toutes les deux heures, on constate également que la quantité de lait et sa qualité varient considérablement d'une traite à l'autre et qu'aux mêmes heures les mêmes variations se reproduisent chaque jour. Ces heures varient suivant les vaches.

Pour finir ces expériences nous avons, sur un lot de vaches non choisies, établi le régime des trois traites équidistantes avec l'espoir d'obtenir une quantité de lait plus grande et de composition plus constante. Les résultats obtenus n'ont pas été conformes à nos prévisions. Le lait du matin a conservé une richesse butyrique notablement inférieure à celle du lait des deux autres traites. Les moyennes ont été le matin 29 par mille, le midi 37 par mille et le soir 34 par mille.

Nous pouvons tirer des faits que nous venons de relater les conclusions suivantes:

1. Le régime des deux traites équidistantes fournit un lait idéal au point de vue de la qualité qui est sensiblement la même aux deux traites.

2. La quantité de graisse éliminée est sensiblement la même quelque soit le nombre de traites.

3. Le système des trois traites doit être conservé pour les vaches à grand rendement dont le lait est vendu en nature ou transformé en fromage, l'extrait sec dégraissé pour cent restant le même quelque soit le régime.

4. Le système des trois traites doit être abandonné dans tous les cas, parce que antiéconomique pour les vaches à rendement en dessous de 12 litres par jour.

5. La question de savoir s'il y a avantage à adopter le régime des deux traites pour les vaches à rendement compris entre 12 et 28 litres et plus, dépend des frais qu'entraîne la troisième traite et diffère par conséquent suivant chaque cas particulier.

[Abstract.]

A CONTRIBUTION TO THE STUDY OF THE VARIATIONS IN THE COMPOSITION OF MILK.

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It would seem that the composition of milk varies little from day to day, but extensive investigations made by the author have proved the contrary to be true. The author treats this subject from the standpoint of seasonal variations and daily variations.

General seasonal variations.—Various investigators differ as to the season when the fat content of milk is greatest. Monvoisin contends the maxima occur in the spring and the minima in the fall; Eckles and Brioux discovered a minimum at the beginning of the summer and a maximum at the beginning of winter; others say the maxima occur at the end of the summer season; Kort states the maxima are found during January and February and the minima during July and August. The author's conclusions (which agree with the latter) are represented by two graphs, one showing the seasonal variations in fat and the other similar variations in the dry solids not fat.

In 1921 the maximum fat content was reached in September, October; in 1922 also in September, with a minimum in May, June, and July, which leads the author to conclude that the beginning of autumn and spring are the seasons for maxima.

The most important factor in explanation of these results is the season of calving. It was our purpose, in the herd we studied, to

distribute the calves throughout the course of the year, but in spite of our efforts a good many calves were dropped at the beginning of the winter. The next year the cows were admitted to the herd after calving, thus assuring a continual introduction of "fresh" cows. This arrangement made no change in the seasonal variations.

Many think that the abundance of pasturage in the early spring and the depleted pasturage in the autumn, supplemented by the feeding of concentrated foods, explain these variations.

In 1918, 1919, 1920 the author studied a herd of 60 to 80 cattle which was fed in the winter on beets, nut cake, and hay and in the summer on a similar diet, excepting the beets for which pods and green clover were substituted. The results were the same as for cattle passing a season on good pasturage.

Seasonal fluctuations in dry solids not fat.—This variation is analogous to that of the fat content. The maxima are attained during March, April, and May and the minima during June and July. It is evident that this variation is also affected by the time of calving.

Influence of the time and frequency of milking.—Should cows be milked twice or thrice daily? In Belgium, milking morning, noon, and night is quite common practice. The morning milking generally furnishes about 45 per cent of the daily supply, the noon milking about 25 per cent, and the evening milking about 30 per cent. The nature of the milk, and particularly the fat content, is affected by the time of milking, for example, the fat content ranges as follows: Morning, 2.8 per cent; noon, 4.0 per cent; and night, 3.5 per cent.

In Holland and parts of Belgium it has been found that, economically, the thrice-daily milking program is scarcely justifiable for the increased production compared with increased cost. In twice-daily milking the decrease in production is about 1 per cent per cow for cows giving less than 10 liters per day and 10 per cent per cow decrease for heavy milkers giving 30 liters or more per day. For a herd the total average decrease is about 6 to 7 per cent.

As to the diminution in butterfat yield in twice-daily milking, it has been found that in some cases there is a daily decrease of from 1 to 1.5 per cent. However, the same has been found in cases of thrice-daily milking. We tried twice-daily milking at 5.30 morning and evening. The results are given in a graph. We also tried thrice-daily milking with the hope of obtaining more milk and higher quality. The results were not as we had anticipated.

As to the quantitative modifications, we found that for morning milking (thrice daily) the average during January was 2.7 per cent of butterfat; for a twice-daily program the average was 3.4 per cent; for evening milking the average was lowered from 3.5 to 3.7 per cent butterfat (thrice-daily milking) to 3.35 to 3.4 per cent twice-daily milking.

In conclusion we would say that twice-daily milking (every 12 hours) gives an ideal milk in point of quality which is about the same for both morning and evening. The quantity of fat is practically the same wherever the program is used. The thrice-daily system should be used for heavy milkers whose milk is used for cheese, and it should be abandoned in cases where it is uneconomical to use on cows giving less than 12 liters daily. The feasibility of the

twice or thrice daily milking program, in reality, depends upon the advantages offered in each particular situation.

A COMPARISON OF PRESENT-DAY MEASURES OF THE PRODUCTIVE VALUE OF FEEDING STUFFS, AND THE NUTRITIVE REQUIREMENTS OF DOMESTIC ANIMALS.

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During the last three decades, our fundamental conceptions regarding the principles of practical feeding have been completely recast. The main idea in this work has been to determine the productive values of different feeding stuffs by direct experiments in feeding. In this way results have come from three different quarters, and all three have been shown to be quite applicable in practical work. The Scandinavian food unit, Professor Kellner's starch value, and Professor Armsby's net energy value have all been quite extensively used as measures of the productive value of feeding stuffs and the nutritive requirements of domestic animals.

Of these different measures of the productive value of feeding stuffs, the Scandinavian food unit is the oldest. The basis for this method of valuation was formed by the feeding experiments commenced in the late eighties by N. J. Fjord, and continued after his death by the Danish Agricultural Experiment Station (Forsøgslaboratoriet), and, after 1908, also by the department of animal husbandry of the Swedish Central Agricultural Experiment Station. With the advent of the cow-testing associations in Denmark and Sweden during the late nineties, the food unit calculation came into more extensive practical use, and in the course of its application it has been developed in conformity with the experimental results which appear in the publications of the above-mentioned institutions (1, 2). It was in 1913 that I (3) first succeeded in working out a method for calculating food values in the production of milk, based on composition, and later I have had occasion to demonstrate the practical application of the method by more detailed investigations (4, 6) in which it was used to indicate the nutritive requirements of domestic animals.

The calculation of food units is chiefly based on feeding experiments with milk cows. Altogether, no less than 52 different feeding stuffs have been compared in the Swedish practical feeding experiments with cows, which have hitherto included no less than 240 testing groups with 1,398 cows. The food unit is thus a measure of the productive value of the fodder in the feeding of milk cows, and it has come into extensive use in Sweden, Denmark, Norway, Finland, Poland, Schleswig-Holstein, and other countries. During the last few years, textbooks on the feeding of farm stock have been published both in Poland and in England, in which this unit has been adopted as the basis for exposition.

Kellner's method of starch value calculation was completed in 1905. In later editions of his great work on feeding (7), Kellner has included the results of investigations which were not complete when the method was first published, and has also had occasion amply

to justify his previously published feeding standards. The starch value calculation is based on feeding experiments with individual fattening oxen which were placed in the respiration apparatus. Only about 30 feeding stuffs were tried, but with the guidance of the results obtained, the productive values of a very large number of feeding stuffs have been obtained. In explaining his method of calculation, Kellner emphasized that it was only fully applicable to the feeding of ruminantia, but it has been used by himself, as well as his successors, as a universal measure of the productive value of feeding stuffs.

In practical work, the starch value calculation has taken first place in Germany, where it has come to be the essential basis for the valuation of fodder by the cow-testing associations, and also for the feeding of farm stock. It has also found some use in the neighboring countries in connection with the feeding of farm stock, and it has been known as a theoretical measure of the productive value of fodder ever since the question of scientific feeding has been studied.

Armsby's investigations on the net energy values of the different feeding stuffs were started in 1902. He also worked with fattening oxen, which were placed in the respiration calorimeter, from time to time, under such conditions that the heat lost by the animals could be accurately measured. By subtracting this from the metabolizable energy of the feeding stuffs being tested, he could accurately calculate the actual net energy values of the various fodders. The investigations of Armsby and his coworkers (8) include only 11 feeding stuffs, but by taking into account a number of older investigations by Kellner and Köhler, he was able to include in the account of his trials the value of metabolizable energy as well as the thermal and net energy for 22 feeding stuffs altogether. In his great work (9) on feeding, published in 1917, he set forth the views at which he had arrived as the result of his investigations. He expresses the productive value of the feeding stuff in "therms," by which expression he indicates a net energy value of 1,000 calories, and gives a simple method for calculating the net energy value of the feeding stuffs on the basis of their analyses. He also calculates the nutritive requirements of different animals in the same manner.

In this way the net energy value was arrived at, so that it could be applied to practical feeding, just as the fodder unit and the starch value, and this may likely have been done in the United States during recent years. From a theoretical point of view, Armsby's net energy value has also attracted much attention among European investigators.

In all the three methods mentioned for calculating food values as a measure for the nutritive requirements of farm stock, it is usual to give certain measures of minimum requirement of protein for the different animals. Only when these requirements are fulfilled, do the authors of the various methods of calculation consider it justifiable to express the effect of the feed as a whole in terms of a unit.

Naturally it is of the greatest interest to get a comparison between the different measures of the productive values of feeding stuffs which have been worked out during the last decades. As Armsby's own work was cut short by his death in October, 1921, it is absolutely

necessary for us to examine how his measure agrees with those resulting from contemporary European investigations. It is clear that even the ideas of food units and starch values carry with them the idea of net energy value, but while the American investigator measured the effect of the feeding stuff direct in calories, his European colleagues sought to determine the effect which a certain feeding stuff can give. Kellner has, as the measure of his unit, chosen the amount of body fat produced on an average from 1 kilo of starch in the fattening of ruminantia, and the Scandinavian method is based on 1 kilo of normal corn, 1 kilo of dry solid in roots, or the amounts of other feeding stuffs which in the production of milk give the same effect as these. Our investigations must therefore be based on the recalculation of the effect of starch values and food units in calories.

In the first place, we come to the comparison between starch value and Armsby's net energy value, as both these units are based on the fattening of ruminantia. Kellner calculates that 1 kilo starch value in the fattening of ruminantia gives on an average an increase of body fat of 248 grams. As 1 gram of animal fats contains 9.5 calories, 1 kilo starch value thus corresponds to $248 \times 9.5 = 2,356$ calories. This figure is the connecting link between starch value and therms; and with the help of this, each unit can easily be calculated into another.

The methods worked out by both investigators for calculating food values on the basis of the analysis of the feeding stuff differ considerably from one another. Both, however, rest on the content of digestible nutritive substances, and Armsby, with his more summary method of calculation, contents himself with common factors for the different kinds of feeding stuffs as measures of the average value of the digestive food material in them. Kellner, on the other hand, starts from each digestible food material separately, and calculates with a relative figure for each which is based on direct experiments with each. The nitrogen-free-extract and crude fiber are multiplied by 1; the fat, according to its origin, by 1.91, 2.12, or 2.41; and the protein, by 0.94. In both cases, deductions must be made from the values found. Kellner reckons with the "Wertigkeit" of the feeding stuff; i. e., with the figure which for each feeding stuff expresses the effect found by experiment as a percentage of the value calculated according to the above method. Armsby subtracts from his figure calculated for the metabolizable energy the loss of heat found by experiment. If this has not been found by experiment it must be estimated by comparison with other similar feeding stuffs. This is also the case with the "Wertigkeit" figure.

To make possible a full comparison between Armsby's and Kellner's methods of calculation, the calculations of the starch value and net energy of normal Swedish barley are given below.

Kellner.

Digestible protein-----	$6.5 \times 0.94 =$	6.11
Digestible fat-----	$1.7 \times 2.12 =$	3.60
Digestible extract and crude fiber-----	$63.1 \times 1 =$	63.10
Total-----		72.81
$\frac{72.81 \times 99}{100} = 72$ kilograms starch value.		

Armsby.

	Therms.
Metabolizable energy (therms) : 72.2 kilograms digestible organic matter, at 39 therms-----	281. 58
Thermic energy : 85.7 kilograms dry solid, at 1,141 calories-----	97. 78
Net energy per 100 kilograms-----	183. 80

$183.8 \div 2.356 = 78.01$ kilograms starch value.

As will be seen, the means are different but the results are quite concordant. That Armsby, in a number of cases (as, for example, barley), found the average value of the same feeding stuff to be somewhat higher than Kellner's may very well be due to the fact that the American feeding stuffs often contain a higher percentage of dry matter than the corresponding European ones, while the data of Henry and Morrison also often show a somewhat higher digestibility. The somewhat higher food value, according to Armsby, is certainly also connected with the fact that he used somewhat younger and better animals for fattening than Kellner.

A comparison between the food unit calculation and the net energy value can be obtained in several different ways. According to the tables introduced into the author's *Handbok i Utfodringslära*, with food standards for different animals, the starch value of the food unit varies in mixed food rations between 0.68 and 0.72 kilogram. Taking a mean value of 0.7 kilogram starch value as corresponding to 1 food unit, this would correspond to $0.7 \times 2,356 = 1,650$ calories. If, again, Armsby's method of calculation is adapted to Swedish feeding stuffs, a somewhat higher figure is arrived at. We have already seen from the foregoing that normal barley contains 183 therms per 100 kilograms. A. Westerlund has arrived at the same average figure by calculating the net energy value of 20 Swedish foods by comparing their dry solid matter with that given for the same feeding stuff by Armsby. In similar calculations made according to Armsby's directions for 16 of our most commonly used feeding stuffs, the author has arrived at the average figure, 178 therms per 100 food units. The reasons why Armsby's method of calculation thus gives somewhat higher figures than the starch value calculation may therefore be those given above.

The attempt to express the net energy value of the food unit as a fixed figure which corresponds to its average value in the fattening of ruminantia may not be of great importance. The food unit is determined with respect to milk production, and from this it derives its prime significance. But complete determinations of energy metabolism in milk production have not yet been carried out. On the other hand, it should be possible, as in the case of the starch value, to calculate the net energy value of the food unit on the basis of the amount and heat value of the product obtained.

Guided by the experience gained in the Swedish cow-testing associations and by calculations based on the feeding and milk production of the herds of those associations where the feeding has been best arranged, the author, as early as 1902, estimated the feed requirements of milk cows at one-third food unit per kilogram of milk produced. The correctness of this figure is confirmed by the average result of the cow-testing associations where the control is carried out with sufficient accuracy and where the feeding is ad-

justed to the nutritive requirements of the various cows. As an example of this, the average results of the cow-testing association for a couple of years in the county of Malmöhus prior to the great war have been given in the following table, and are compared with similar results obtained by the associations in the county of Östergötland after the war. In both districts the stock was chiefly Holsteins and Ayrshires, in the former chiefly Holstein and in the latter chiefly Ayrshire breeds. The average weight of the cows in Malmöhus district was thus estimated at 525 kilograms and in Östergötland district at 500 kilograms. As maintenance feed 1 food unit was calculated per 150 kilograms of live weight.

TABLE 1.—*Milk production per food unit in the Swedish cow-testing associations.*

	County of Malmöhus.		County of Östergötland.	
	1906-7	1914-15	1919-20	1920-21
Number of tested cows	33,500	41,597	17,008	18,794
Average milk production.....kilograms..	3,377	3,694	2,827	3,070
Fat.....per cent..	3.23	3.24	3.47	3.50
Total feed used.....food units..	2,400	2,500	2,123	2,235
Maintenance feed.....do.....	1,277	1,277	1,205	1,205
Difference as production feed.....do.....	1,123	1,223	918	1,030
Milk per food unit.....kilograms..	3.01	3.02	3.09	2.98

From the table it appears that the figure 3 kilograms milk per food unit of production feed regularly results as the average from several tens of thousands of controlled cows for different years. It also shows that this yield can be attained up to an average fat percentage in the milk of 3.5.

The energy content of the milk varies appreciably with its fat content. On the basis of exhaustive investigations, partly by the author and partly by the Danish Agricultural Experiment Station, the average value for milk with 3.5 per cent of fat can be estimated at 700 calories per kilogram. Three kilograms milk thus contain 2,100 calories, and this figure must thus be accepted as representing the net energy value of a Swedish food unit until more detailed investigations can be made on this subject.

This net energy value per food unit which has been demonstrated for milk production is, however, appreciably higher than that previously calculated in connection with fattening. The figure found by comparison with the starch value, 1,650 calories per food unit, would thus increase by not less than 450 calories, or 27 per cent, in milk production. The explanation of this may possibly be partly that the proteins of the feed are better utilized in milk production than in fattening, and partly that the other nutrients of the fodder are converted into milk with less loss than into fat. Kellner states that in the experiments on which he based his starch value calculations, each kilogram of digestible protein gave an average increase of fat of 235 grams; i. e., $235 \times 9.5 = 2,232.5$ calories, which means that the net energy in this case amounts to 39.1 per cent of that of the nutrients given. From experiments made by the author (2, No. 206) it was shown that about 75 per cent of the carefully measured proteins in the production ration of milk cows was found as milk

proteins. In milk production it thus appears that about 36 per cent more of the total energy of the proteins can be recovered than is possible in fattening, which means that of the 135 grams digestible protein per food unit which we regard as the minimum for cows in milk production, 278 calories more are recovered than in fattening. If these 278 calories are added to 1,650, then 1,928 calories would be found available for the production of milk.

But also the digestible carbohydrates of the fodder could surely be better utilized in milk production than in fattening of ruminantia. As is well known, the carbohydrates are assimilated and occur in the blood in the form of grape sugar. In fattening, fat has to be formed from this grape sugar, while in milk production the grape sugar is converted into milk sugar in the udder. It is obvious that the latter change occurs with considerably less loss than the former, which seems to explain quite satisfactorily, the increase in the net energy of the food unit which lies between 1,928 and 2,100 calories. The complete explanation of these processes is, however, not available yet.

The views set out above have led the author to adopt (3), in the calculation of the milk production value of feed, an alteration of Kellner's method for calculating the starch value, the factor for protein being raised from 0.94 to 1.43. The latter figure is calculated so that the protein in milk production is assumed to be utilized as efficiently as the carbohydrates in the fodder, and the factor is therefore calculated on the basis of the total heat value of the protein (5.71 calories) as this is the proportion with respect to grape sugar, cane sugar, starch, and cellulose (4 calories). For the rest, Kellner's method of calculation is followed. The value of feed thus calculated for the feeding of milk cows has been named "milk-production value" to distinguish it from Kellner's starch value, and the values obtained with the different feeds all come near to the results of the Scandinavian feeding experiments with milk cows which were carried out when this method of calculation was brought out in 1913. By comparison with the food units determined by the experiments mentioned, it was made clear that a food unit corresponds on an average to 0.75 kilogram milk-production value; this means that as the food unit contains a net energy value of 2,100 calories, then 1 kilogram of milk-production value corresponds to a net energy value of 2,800 calories.

With the help of the methods described, it became possible to calculate the food values of feeding stuffs of varying composition, as soon as their content of digestible nutritive matter was known. Thus the milk-production value and the number of food units per 100 kilograms of normal Swedish barley, with the content of digestible nutrient substances shown below and a value figure (Wertigkeit) of 99, is calculated as follows:

Digestible protein-----	$6.5 \times 1.43 = 9.3$
Digestible fat-----	$1.7 \times 2.12 = 3.6$
Digestible nitrogen free extract and crude fiber-----	$63.1 \times 1 = 63.1$
Total-----	76.0

$$\frac{76.0 \times 99}{100} = 75.2 \text{ kilograms milk production value.}$$

$$75.2 \div 0.75 = 100.3 \text{ food units per 100 kilograms.}$$

The milk production values for the Swedish feeding stuffs given in the author's works (4, 6) are calculated according to this method. It should be observed in this connection that the value figures (Wertigkeit) of a large number of the feeding stuffs named have been determined by comprehensive feeding experiments with milch cows. These have as a rule been carried out as group tests with 6 cows in each group, according to principles which have previously been described by the author (5). With the guidance of the composition and digestibility of the feeding stuffs tested, their milk-production values have been calculated as shown above, and the value figures (Wertigkeit) of the different feeding stuffs, like the effects measured in the experiments, were expressed as percentages of that calculated on the basis of the digestible nutritive matter in the feeding stuffs.

The experiments made have thus shown that food units, milk-production values, starch values, and net energy values are concepts corresponding in a high degree with one another, if only it is remembered that they are intended for different kinds of production. The food unit, like the starch value, rests on positive determinations of the animal products obtained, and Armsby's net energy value on a negative estimation, by help of which the actual effect can be calculated more accurately than was previously the case. We have seen from the foregoing how closely the results must be regarded as corresponding with one another if they are properly understood; and subject to the limitations pointed out above, the average values of the different measures can be expressed thus:

In fattening of ruminantia :	Calories.
1 therm -----	1,000
1 kilogram starch value -----	2,356
1 food unit (average figure) -----	1,650
In milk production :	
1 kilogram milk production value -----	2,800
1 food unit -----	2,100

The results hitherto available regarding the utilization of the metabolizable energy within the body of the animal, in the feeding of work horses and fattening pigs, are not yet sufficiently conclusive to form the basis of certain figures. Armsby, therefore, says provisionally (9) that both of these kinds of animals utilize the energy in feeding stuffs which are suitable for them, at least just as well as milk cows. This seems to be confirmed as far as fat pigs are concerned, partly by Fingerling's well-known investigations on the ability of these animals to utilize the different feeding stuffs and partly by the calculations made by the author on the basis of Swedish feeding experiments with over 1,600 pigs and 34 different feeding stuffs.

With regard to the figures just given, it must, however, be remembered that the net energy of the feeding stuff is only one of the factors which determine the effect of a certain feeding mixture. It is certainly the most important, but the net energy of the mixture is not completely utilized if some other factors are not at the same time at hand. Thus, the content of digestible proteins in the feeding stuff should in any case constitute the minimum requirement of the animal of this nutrient substance, if its greatest possible effect is to be attained, and similarly it should be observed that if too great a

proportion of the total feed consists of proteins, in comparison with what is required, then this will involve a lowering of the net energy of the feeding mixture.

Moreover, according to investigations of recent years, a certain amount of vitamins must be present in the total feed, in order that the production shall proceed normally, and the same is the case as regards the mineral substances necessary for the building up of the body and the metabolism of the food. Both these factors may affect the production in a high degree. In this connection the importance which phosphorus seems to have in milk production, according to recent American researches, should also be remembered.

The dietetic effect of the mixed feeds—i. e., their effect on the course of digestion, their constipating or laxative action, concentration or palatability, etc.—has also a certain influence on the production. For each feeding stuff one might reckon with an optimum amount which should not be exceeded. In some cases, as for rape seed cakes, meat meal, and molasses, this optimum lies relatively low; in others, as for grain, roots, and hay, it is fairly high, but the best effect is attained only by seeking to balance the one-sided influences of the various feeding stuffs by mixtures of as many sorts as possible.

Finally, it should not be forgotten that the effect of the feed is always influenced to some extent by its size in relation to the nutritive requirements of the animal, i. e., to the normal scope of its functions. The cow producing large quantities of milk requires more nourishment than the one producing less or none at all, and the efficient utilization of the feed is to a large degree dependent on our correct estimation of the requirements in any particular case. If the allowance is too large, the result is, as has been shown in many trials, that the digestibility of the feed is diminished; i. e., a larger proportion of its gross energy passes away through the alimentary canal. In the same way, a larger proportion of the gross energy of an excessive amount of protein passes away with the urine. It has not yet been fully determined what the effect of such feeding is on the utilization of the metabolizable energy, but possibly it also causes a loss of heat. This at least seems to be the case in the utilization of proteins as fattening feed for ruminantia.

All this means that the net energy of the different feeding stuffs can not be expressed in general figures applying to all cases, not even if they have the same composition and are used for the same animals. The net energy values are not to be understood as absolute values but as average figures which give a fair expression for the relative value of a feeding stuff in a certain production. It is only when they are understood in this way that we shall find full use for them in practical work.

SUMMARY.

The measures of the productive values of different feeding stuffs, evolved during the last three decades—the Scandinavian food unit, Kellner's starch value, and Armsby's therms—must all be looked on as measures of the net energy of the feeding stuffs. They differ from one another in that the Scandinavian food units have been derived from feeding trials with milk cows, while Kellner and Armsby

worked out their units from fattening trials with oxen. The various units can be compared with one another by recalculating the effects obtained from each unit as calories.

Armsby's therms have been directly determined in this way, and correspond to a net energy value of 1,000 calories.

Kellner's starch value is equivalent to the effect of 1 kilogram of starch in the fattening of ruminantia. From this, an increase of fat amounting to 248 grams has been attained, which, as body fat contains 9.5 calories, means that 1 kilogram starch value corresponds to 2,356 calories.

A food unit corresponds to 1 kilogram of barley or 1 kilogram of dry solids in roots or other feeding stuffs, with a milk production value of 0.75 kilograms. A food unit in cow's production fodder, containing at least 135 grams of digestible proteins, has been shown to produce on an average 3 kilograms of milk with an average fat content up to 3.5 per cent. As milk with this fat content contains 700 calories, 1 food unit corresponds to a net energy value of 2,100 calories in milk production, and 1 kilogram milk production value to 2,800 calories.

In feed mixtures usable in practice, 1 food unit corresponds to 0.7 kilograms starch value, on an average. The net energy of the food unit in fattening of ruminantia thus becomes $0.7 \times 2,356 = 1,650$ calories. The higher net energy of the food unit in milk production depends on the fact that in this case the proteins of the fodder, as well as the carbohydrates, are better utilized than in fattening.

According to investigations by Fingerling, Armsby, and others, the fully utilizable net energy of feeding stuffs seems to be of the same order in the feeding of work horses and fat pigs as in milk production.

At the same time, the utilization of a certain feeding stuff—i. e. its yield as net energy—is not only dependent on the kind of animal and the direction taken by the production, but also on the amount of digestible proteins, mineral substances, and vitamins in the feeding mixture, and is influenced further by the dietetic effect of the mixture, palatability, and concentration, as well as by the size of the daily ration in proportion to the normal nutritive requirements of the experimental animals. All this implies that the net energy values of the feeding stuffs are, in any case, not to be understood as absolute figures, but as average values which give a fair expression of the relative value of a feeding stuff in a certain kind of production.

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FEEDING STANDARDS AND THEIR USES.

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Everyone familiar with the scientific aspects of stock feeding appreciates the fact that during the past decade epoch-making discoveries have been made regarding animal nutrition. These developments, as all of us know, include especially the investigations on vitamins, on the mineral requirements of stock, and on the differences in the nutritive value of various proteins.

So thoroughly have these recent findings overturned some of the older theories of nutrition, that many have been inclined to believe that the old conceptions of *feeding standards* and *balanced rations* have outlived their usefulness and are now of little importance. In my opinion, however, our modern knowledge of nutrition has merely shown us more definitely the limitations of feeding standards.

In practically no instances have the agricultural scientists who have formulated feeding standards, even those presented years ago, advanced these standards as all-inclusive and ironclad recipes for stock feeding. They have realized that there are many factors in the making up of efficient rations which can never be taken into consideration in any set of feeding standards. Feeding standards are, and have been in the past, merely attempts to express in definite form the amounts of digestible protein and of total digestible matter or of energy which should be provided in the rations for farm animals of the various ages and classes. The protein requirements may be expressed either in terms of *digestible protein* or *digestible crude protein*. Total digestible matter may be expressed as pounds of *digestible nutrients*, *therms of net energy*, *starch values*, or *feed units*.

Before proceeding with a comparison of various present-day feeding standards and a discussion of their uses, let us trace briefly the development of these aids in stock feeding.

EARLY FEEDING STANDARDS.

The first attempt to express the relative value of different feeding stuffs in a systematic manner was by Thaer, of Germany, who in 1810 published a table of hay equivalents, with meadow hay as the standard. For example, in his table, 91 pounds of clover hay, or 200 pounds of potatoes, or 625 pounds of mangels were considered to equal 100 pounds of meadow hay in feeding value.

In 1859, Grouven proposed the first feeding standard for farm animals, based on the crude protein, carbohydrates, and fat in feeding stuffs. This, however, was imperfect, since it was based on the total instead of the digestible nutrients.

In 1864, Wolff, a famous German scientist, presented the first table of feeding standards based on the digestible nutrients contained in feeds. These set forth the amounts of digestible crude protein, carbohydrates, and fat required daily by the different classes of farm animals. The Wolff standards were brought to the attention of American farmers 10 years later and were further introduced by Armsby's Manual of Cattle Feeding, which appeared in 1880. The value and importance of these standards were soon recognized, and with their adoption came the first widespread effort toward the rational feeding of farm animals.

In 1896 the Wolff standards were modified somewhat by Lehmann, as scientific trials had then thrown further light on stock feeding. One of the chief improvements made was in the recommendations for dairy cows. In the original Wolff standards, the requirements of all milk cows were considered to be alike, regardless of the amount of milk produced or the richness of the milk in butterfat. Lehmann gave separate figures for cows producing four different amounts of milk, but he paid no attention to the fact that milk varies widely in content of butterfat. The Wolff-Lehmann standards were introduced into the United States, and until very recently were used more widely in this country than any other system of standards.

KELLNER'S STARCH VALUES.

As a result of his extensive investigations with steers, conducted by means of a respiration apparatus, Kellner put forth, in 1905, his *starch values*. In these he attempted to measure the actual net energy values of different feeding stuffs by reducing the nutrients they furnished to the equivalent of pure starch. He also formulated feeding standards, in which the requirements of the different classes of animals were expressed in terms of his starch values and of digestible protein (not digestible crude protein).

On account of the great amount of time needed to determine the net energy value of any feed accurately, Kellner was able to determine the starch values of but a few feeds. He, however, computed values for a long list of feeds, basing his computations on the chemical composition of each feed and making certain arbitrary deductions for the losses of energy in the mastication, digestion, and as-

simulation of the different types of feeds. Kellner's starch values and feeding standards have never been used to any appreciable extent in the United States.

ARMSBY NET ENERGY VALUES AND STANDARDS.

Throughout many years Armsby carried on extensive investigations by means of the respiration calorimeter at the Pennsylvania Institute of Animal Nutrition to determine the actual net energy values of typical feeding stuffs. These experiments were carried on chiefly with steers.

The trials during the last few years of Doctor Armsby's life were conducted with dairy cows, but the results of these later investigations have not yet been published.

Armsby measured the net energy of feeding stuffs in terms of therms, a therm being 1,000 great calories. In determining the net energy of 100 pounds of any feed, there are deducted from the total net energy yielded on complete combustion, various losses of energy. The first group of losses include (1) the losses of energy in the undigested material, or the feces; (2) the losses of energy in the combustible compounds, such as urea, in the urine; and (3) the losses of energy in the combustible gases, such as methane, produced in fermentations occurring in the digestive tract. All the energy involved in these losses is completely wasted, so far as serving any use in the animal body.

Deducting these three losses from the gross energy yielded by any feeding stuff, there is obtained the *metabolizable energy*, or *available energy*, of the feed.

Not all of this metabolizable energy can, however, serve a productive purpose in the body, for a part of it is used up in the so-called "work of digestion," which includes the energy expended in the mastication of the food and also in digestion and assimilation. The energy left after all these losses are deducted is the actual net energy yielded by the particular feeding stuff. It is the amount of energy which can be utilized for such productive purposes as the production of an increase in body tissues, the production of external work, or the yielding of milk. A part of the net energy yielded by the feeds consumed, must, of course, be expended for such maintenance needs of the body as the beating of the heart, the work of the muscles in holding the body upright or in propelling it, etc.

Owing to the great amount of labor involved in making studies of this character with the respiration calorimeter or with the respiration apparatus, Armsby and Kellner together determined the actual net energy values for only 21 different feeding stuffs. From the data secured in the studies of these feeds Armsby computed the net energy values for a considerable number of feeds, basing his computations by special permission upon the average composition of the various feeds given in Feeds and Feeding.

Such net energy values are theoretically more accurate measures of the productive values of different feeds than their content of total digestible nutrients. However, such computed values are but ap-

proximations, due to the meager data yet secured. For instance, while practical feeding trials have shown corn to have a somewhat higher productive value than barley for fattening animals, the computed net energy value of barley is given as 89.94 therms, which is slightly greater than that of corn. In a few instances, like that just referred to, the computed net energy values are in fact less accurate measures of the actual relative values of feeds than the amount of total digestible nutrients the feeds furnish.

Furthermore, most of the net energy values which have actually been determined have been secured in trials with mature steers. How far these values hold good for other classes of animals is a question. The few trials reported for other animals show surprising differences in some instances. For instance, Kellner found the net energy value of 100 pounds of starch to be 81.89 therms in trials with steers, while Fingerling found it to be 151.1 therms in trials with swine. Similarly, the net energy value of peanut oil per 100 pounds was found to be 161.71 therms in trials by Kellner with steers, and to be 386.7 therms in trials by Fingerling with swine. For wheat gluten, a similar difference was found, the net energy value being 68.45 therms for steers and 152.3 therms for swine. A comparison of the net energy values for ruminants with those for horses shows similar differences. The computed net energy values must therefore be regarded not as final, but as helpful estimates which point out important general facts concerning the relative value of different classes of feeds.

In comparing the net energy values of various feeds, it should always be borne in mind that net energy is a measure of the value of a feed for productive purposes, such as the formation of flesh or fat, or the production of external work or of milk. The energy used up in the "work of digestion" all takes the form of heat and is wasted so far as such production is concerned, but this heat helps to keep the body warm. Therefore, either the available energy, which includes the energy thus spent, or else the total digestible nutrients, are better measures of the relative value of different feeds for maintaining animals, at least when there is need of a large amount of heat to warm the body, as during winter in the Northern States.

Armsby drew up feeding standards in which the recommendations for the various classes of farm animals were stated in terms of his net energy values, expressed in therms, and of digestible protein (not digestible crude protein, as in the Wolff-Lehmann standards). These standards were later amplified and revised by him. The Armsby standards and net-energy values have been chiefly used in the United States instead of the Kellner starch values and standards by those desiring to compute rations by a net-energy system.

On the basis of our present knowledge of the nutritive values of various proteins and other nitrogenous food constituents, it seems unfortunate to the author that both the Kellner and the Armsby standards express the needs of animals for nitrogenous nutrients in terms of *digestible protein* instead of *digestible crude protein*.

It now seems certain that if the mixture of so-called "*amids*" in a feeding stuff contains the proper proportion of various amino acids,

an animal can use the nitrogen thus supplied the same as that furnished by true proteins. In fact, feeds containing a large proportion of amid nitrogen may even be superior to certain pure proteins. For example, gelatin, a pure protein, will not even meet the maintenance needs of an animal for protein. This is because it lacks two essential amino acids entirely and contains only small amounts of others.

About one-third of the nitrogen of alfalfa hay is present in amid form. Yet in metabolism trials by Hart and Humphrey at the University of Wisconsin it has been found that the nitrogenous compounds of alfalfa hay were just as efficient for milk production as the nitrogenous compounds in a ration of corn grain, corn gluten feed, and corn stover, in which practically all the nitrogen was furnished in the form of true protein.

Attention may also be called to the fact that about half the nitrogen in corn silage is present in amid form, due to the cleavage of proteins in the ensiling processes. On the other hand, only 15 per cent of the nitrogen in cured corn fodder is in amid form. Yet no one will conclude that the nitrogen of cured corn fodder is more available to animals or more efficient in nourishing them than the nitrogen of corn silage.

HAECKER STANDARDS.

One of the most important advances in the scientific feeding of dairy cows was the recognition by Haecker, of the University of Minnesota, that their nutritive requirements depend not only on the amount of milk yielded, but also upon the percentage of butterfat in the milk. He conducted an extensive series of experiments to determine the amounts of nutrients required by milk cows, and drew up feeding standards stating, in terms of digestible crude protein, digestible carbohydrates, and digestible fat, the amounts of nutrients needed, in addition to the maintenance requirements, for the production of 1 pound of milk containing various percentages of butterfat. During his investigations he revised his standards at various times, the final revision being published in 1914. This prescribed materially less digestible crude protein than the Wolff-Lehmann standards, the nutritive ratio being about 1:7 for cows producing approximately 1 pound of butterfat a day. His earlier standards recommended even less protein than this, nutritive ratios as wide as 1:9 being advised.

SAVAGE STANDARDS.

Based on experiments at Cornell University, Savage drew up modifications of the Haecker standards. In these the digestible crude protein was increased so as to provide rations having a nutritive ratio of 1:7 or narrower. A simplification was also made in stating the nutritive requirements in terms of *digestible crude protein* and *total digestible nutrients*, instead of giving separate recommendations for digestible carbohydrates and digestible fat, as in the Wolff-Lehmann and Haecker standards. This simplification accords fully with the use of food in the animal body.

SCANDINAVIAN FEED-UNIT SYSTEM.

Extensive experiments have been conducted in the Scandinavian countries to study the values of various feeds for milk production, especially by Fjord, of Denmark, and Hansson, of Sweden. Based upon these experiments, tables of feed-unit values have been drawn up. These state the amounts of various feeds which it is believed are equal to the standard unit of value, which is 1 pound of such grain as corn or barley.

These feed-units have not thus far been used extensively in the United States. This, to the author, seems fortunate, for they are not true expressions of net energy. In this system feeds rich in protein are given a higher value than feeds low in protein which furnish the same amount of net energy. For example, in the feed-unit system, only 0.9 pound of linseed meal, gluten feed, or dried distillers' grains is required to equal 1 feed unit. Yet, according to Armsby, the net energy value of these feeds is lower than that of corn. Again, the energy value of timothy hay is even higher than that of clover or alfalfa hay, but in the feed-unit system timothy hay is rated 50 per cent below the legume hays. When added to rations deficient in protein, protein-rich feeds are worth more than those which are low in protein, but yet furnish an equal amount of net energy. However, as is well known, when the protein supply in the ration is already adequate, any additional amount of this nutrient is broken down in the body, the nitrogenous portion being excreted in the urine, and only the remainder utilized for the formation of the fat and carbohydrates in flesh or milk, for body fuel, or for the production of work. In all such cases protein will have a value corresponding only to the amount of net energy it furnishes.

Over large sections of our country protein-rich feeds are cheaper than those high in carbohydrates. In the West, with its abundant and cheap alfalfa hay, and in the South, with its low-priced cottonseed meal, it is often necessary to add carbonaceous feeds rather than protein-rich concentrates to balance the usual rations. Thus the feed-unit system does not furnish a safe guide by which the farmer can determine the value of feeds under all conditions. The worth of a given feed to him will depend on the other feeding stuffs with which it is to be combined. In some instances protein-rich feeds will be worth the more, and in others those which are high in carbohydrates.

The feed-unit system has been evolved in a comparatively small region, where similar crops are grown on the different farms and the price of purchased feeds does not vary widely throughout the entire district; hence this difficulty has not arisen there. No arbitrary values for feeding stuffs, expressed in terms of money or other fixed units, can be devised which will hold good under widely differing conditions.

MORRISON, OR MODIFIED WOLFF-LEHMANN STANDARDS.

Up to 1915 the Wolff-Lehmann standards were undoubtedly used chiefly throughout the United States by those desiring to compute

balanced rations for their stock. For dairy cows some of the special standards for milk production, such as the Haecker standards, had come into extensive use, but this was not the case with other classes of stock. This was in spite of the extensive investigations with various classes of animals, conducted especially by the American experiment stations, since the Wolff-Lehmann standards were first presented in 1896. A study of the experimental data available convinced the author of this paper that these old Wolff-Lehmann standards were inadequate and erroneous in many instances. In particular they advised more protein than recent experiments had shown to be necessary for certain classes of animals.

A set of standards was accordingly drawn up and presented in 1915 under the name of the "Modified Wolff-Lehmann standards." These have more recently come to be known by the author's name. These standards are expressed in terms of total dry matter, digestible crude protein, and total digestible nutrients.

Appreciating that feeding standards can never be hard and fast recipes for stock feeding, a range is indicated in the amounts of dry matter, digestible crude protein, and total digestible nutrients advised. When protein-rich feeds are relatively cheap in price, the use of the larger amounts of digestible crude protein is advised, but when protein-rich feeds are high in price, it is believed that it may be more profitable to feed only as much protein as is recommended in the lower figures.

Similarly, when concentrates are cheap compared with roughages, it is recommended that sufficient concentrates be fed to bring the total digestible nutrients in the ration fully up to the higher figures in the standards. On the other hand, when concentrates are high in price it is felt that it may be more economical to restrict the amount of concentrates and provide only enough to meet the lower figures for total digestible nutrients.

FACTORS NOT CONSIDERED IN FEEDING STANDARDS.

It is recognized, as has been stated previously in this paper, that feeding standards can not take into consideration many essentials of efficient rations. For example, it is doubtful whether recommendations regarding the *quality* or *kind* of proteins, as measured by the proportions of various amino acids, can ever be made in feeding standards. Also, as yet no feeding standard has attempted to prescribe the amounts of the various mineral constituents required by farm animals. In view of the intricate way in which the assimilation of calcium from the food seems to be linked with the amount of vitamin D in the ration, it seems that it may be impossible to give recommendations even for this highly important mineral constituent in the confines of a feeding standard. Feeding standards can never consider such factors as the suitability of various feeds for a particular class of animals. For example, all stockmen know that timothy hay is an excellent roughage for horses, but an inferior one for dairy cows.

All such considerations show clearly the limitations of feeding standards. For efficient stock feeding, farmers must be guided not

only by the recommendations of feeding standards, but also fully as much by the results of experiments conducted by the experiment stations with various typical rations. Only by such actual feeding trials can account be taken of all the factors which are necessary to insure success in the feeding of farm animals.

THE COST OF PRODUCING MILK AND SOME FACTORS INFLUENCING THE COST.

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The price received for milk is not determined by its cost of production, yet cost always enters into price in the long run, because when the returns for labor in its production get too low, a decreased supply increases price. The amount of cheap time, such as the time of women, children, and elderly persons, that enters into the production of milk is so great, and on many farms has so little alternative opportunity to produce income, that a slight increase in price reacts quickly in more milk. For years the result has been a price for dairy products that allows very moderate returns per hour spent for the enterprise, yet high enough to provide a sufficient and ever-increasing supply; and likewise a price resulting in a better yearly labor reward for the farm family than any alternative agricultural pursuit in many regions.

The cost of producing milk has been determined many times by farm surveys and farm cost accounts. A list of some publications giving such results appears at the end of this paper. In practically all of the studies of the cost of production of milk the net results have been a loss after interest, wages, feed, and all other costs are deducted from the returns, but usually the returns were sufficient to meet all costs except labor and allow some return for time. Whenever a loss results by cost-accounting methods, the conclusion must be that either the persons employed for the enterprise received less than the per hour rate at which their time was charged, or that the farmer received less than the rate of interest charged on his investment in the enterprise, or that he sold the farm-grown roughage to animals at less than the farm value at which it was charged.

The charges in producing milk may be classified as feed including pasture, bedding, human labor, horse labor, interest on cows, depreciation on cows, use of buildings, use of equipment, bull service, and miscellaneous items. The credits may be classified as manure, calves and calf hides, milk and milk products used, and miscellaneous items. The difference between these charges and credits will give the cost of producing the milk sold.

The commonly accepted method of computing cost of production is to consider the charges and credits for the cow part of the dairy enterprise only. In so doing the cost of maintaining the herd bulls is calculated as a separate item and charged to cows, as bull service. No charges or credits for heifers are included.

FEED AND LABOR USED IN MILK PRODUCTION.

The longest continuous records of feed used and of production of cows appear in reports and bulletins from experiment stations. Table 1 gives a summary of several of these.

TABLE 1.—*Feed used and production per cow in experiment station herds.*

Station.	Number of years covered by record.	Number of records.	Milk.	Butterfat test of milk.	Butterfat.	Concentrates.	Silage.	Other succulent feed.	Hay.	Other dry forage.
			<i>Lbs.</i>	<i>Per ct.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>
Connecticut ¹	10	227	5,947	4.67	278	2,277	8,535	176	1,859	38
Massachusetts ²	15	131	6,036	5.07	306	2,155	1,820	3,118	4,820	278
Michigan ³	1	29	6,610	3.71	245	2,774	3,649	1,990	3,252	734
Minnesota ⁴	1	23	6,408	4.70	301	3,474	3,479	1,827	2,029	.....
Missouri ⁵	1	12	5,927	4.18	248	3,027	.....	.....	3,480	.....
Montana ⁶	1	15	5,992	4.17	250	1,169	.....	.....	6,468	.....
Nebraska ⁷	2	52	8,796	3.87	340	1,981	3,684	.....	2,343	.....
New Jersey ⁸	14	415	6,792	4.16	283	2,721	8,008	8,076	1,383	679
Utah ⁹	5	49	5,601	4.23	237	1,305	.....	.....	4,518	.....
Wisconsin ¹⁰	12	261	7,540	4.28	322	2,014	7,549	1,648	1,356	.....
Total.....		1,214	.....	.....	.....	.....	.....	.....	.....	.....
Simple averages:										
Per cow.....			6,565	4.30	281	2,290	3,672	1,684	3,151	173
Per 100 pounds of milk.....			.....	.....	.....	34.9	55.9	25.7	48.0	2.6
Per pound of butterfat.....			.....	.....	.....	8.1	13.1	6.0	11.2	.6

¹ Bulletins 29, 73.² Bulletin 143.³ Bulletin 166.⁴ Bulletin 35.⁵ Bulletin 26.⁶ Report 1905.⁷ Bulletin 101.⁸ Reports 1897-1906, 1909, 1912-1915.⁹ Bulletin 68.¹⁰ Reports 1905-1907; Bulletins 102, 187, 217.

The average amounts of feed used per cow in 10 experiment station herds for the years reported, were: Concentrates, 2,290 pounds; silage, 3,672 pounds; other succulent feed, 1,684 pounds; hay, 3,151 pounds; other dry forage, 173 pounds. The amount of pasture is not reported. The average yield of these cows covering 1,214 records was 6,565 pounds of milk containing 281 pounds of fat, making the average test 4.3 per cent.

The quantities of feed per 100 pounds of milk were: Concentrates, 34.9; silage and other succulent feed, 81.6; dry forage, 50.6; and per pound of butterfat, concentrates, 8.1; silage and other succulent feed, 19.1; dry forage, 11.8. No labor was reported for the station herds.

Table 2 gives the average quantities of feed and labor used for 22,836 cows on 1,077 farms in 9 States and Provinces.

TABLE 2.—*Feed used and production per cow in farmers' herds.*

State.	Year.	Publication.	Number of farms.	Number of cows.	Feed.	
					Concentrates.	Succulent roughage.
					<i>Pounds.</i>	<i>Pounds.</i>
Wisconsin.....	1920-21	Wis. Bul. 345.....	24	384	1,555	8,430
Delaware.....	1919-20	U. S. D. A. Bul. 1101.....	16	530	1,885	2,760
Michigan.....	1914-15	Mich. Bul. 277.....	25	888	2,343	7,729
Iowa.....	1916-17	Iowa Bul. 197.....	58	900	1,785	5,342
New York.....	1914-15	Cornell Bul. 409.....	149	2,058	1,407	4,643
Do.....	1918-19	Cornell Memoir 64.....	163	4,136	1,077	2,398
Wisconsin.....	1920	U. S. D. A. Bul. 1144.....	48	630	1,990	7,591
Vermont.....	1916-17	Vt. Bul. 209.....	212	4,650	1,240	5,840
Indiana.....	1915-17	U. S. D. A. Bul. 858.....	21	738	2,046	7,276
Connecticut.....	1916-17	Conn. Ext. Bul. 7.....	178	3,258	2,100	8,200
New York.....	1921-22	Cornell Bul. ²	83	2,073	1,632	4,473
Michigan.....	1916-19	Mich. Bul. 286.....	25	1,240	1,868	7,653
Do.....	1916-18	Mich. Bul. 286.....	25	731	1,141	7,015
Ontario.....	1920	Ont. Bul. 284.....	50	620	2,450	6,781
Total.....			1,077	22,836		
Simple averages per cow.....					1,751	6,152
Simple averages per 100 pounds of milk.....					28.7	100.8
Total corresponding to 8 areas reporting fat.....			506	11,890		
Simple averages per cow when butterfat was recorded.....					1,576	5,581
Simple averages per pound of butterfat.....					7.2	25.4

State.	Feed—dry forage.	Pasture.	Labor.	Milk produced.	Test of milk.	Butter-fat produced.	Per cent of net cost of milk represented by barn feed and human labor.
	<i>Pounds.</i>	<i>Days.</i>	<i>Hours.</i>	<i>Pounds.</i>	<i>Per cent.</i>	<i>Pounds.</i>	
Wisconsin.....	2,867	168	149	7,115	3.78	269	79.8
Delaware.....	3,289		140	5,439	3.60	196	
Michigan.....	3,321		¹ 175	7,042			
Iowa.....	4,383	169	147	4,565			86.4
New York.....	4,162	159	187	5,532	4.00	222	83.9
Do.....	5,037	169	180	5,173	3.53	183	85.5
Wisconsin.....	3,025		171	7,320			
Vermont.....	3,500		158	5,328			84.2
Indiana.....	3,301		164	6,937	3.70	257	
Connecticut.....	3,880	150	163	6,009			85.7
New York.....	4,414	165	145	5,272	3.45	182	83.4
Michigan.....	3,413	160	¹ 147	7,211	3.35	242	
Do.....	3,404	153	¹ 117	6,047	3.45	209	
Ontario.....	3,318		190	6,500			
Total.....							
Simple averages per cow.....	3,665	³ 162	160	6,106			⁴ 84.1
Simple averages per 100 pounds of milk.....	60.0		2.6				
Total corresponding to 8 areas reporting fat.....							
Simple averages per cow when butterfat was recorded.....	3,736			³ 6,091	³ 3.61	³ 220	
Simple averages per pound of butterfat.....	17.0						

¹ Does not include milk hauling.² In process of publication.³ Average of eight areas.⁴ Average of seven areas.

Several publications report studies of farmers' herds and are of interest in this connection, but do not give the amounts of feed used by cows separate from that used by bulls and by heifers. The data, therefore, are not used in Table 2. Reference is made to these publications at the end of this paper.

The average quantities of feed and labor used per cow in these 1,077 farmers' herds were: Concentrates, 1,751 pounds; succulent feed, 6,152 pounds; dry forage, 3,665 pounds; and hours of labor per cow, 160.

The most expensive feature of maintaining animals is the cost of winter feed. The winter period in the areas of the United States reported was about 203 days. In the western part of the United States, where hay and grain are cheaper, the feed cost of wintering a cow is less than in the East. In countries where the grazing period is longer the cost of maintaining an animal is less.

For eight areas, covering 14,780 cows, the average days on pasture were 162 per cow. Days pastured for the remaining areas were not reported. The average production of cows on these 1,077 farms was 6,106 pounds of milk. For eight areas, including 506 farms and 11,890 cows, the butterfat test of milk was reported. On these farms the average production was 6,091 pounds of milk, testing 3.61 per cent fat, resulting in 220 pounds of butterfat per cow. Butterfat was not reported on the remaining farms.

The quantities of feed used per 100 pounds of milk were: Concentrates, 28.7; succulent feed, 100.8; dry forage, 60 pounds. The labor averaged 2.6 hours per 100 pounds of milk produced.

The quantities of feed used per pound of butterfat for the areas reporting butterfat production were: Concentrates, 7.2 pounds; succulent feed, 25.4 pounds; dry forage, 17 pounds.

A comparison of the feed used per unit of product by cows in experiment station herds and on farms is given in Table 3.

TABLE 3.—*Feed used per unit of product in experiment station and farmers' herds.*

Kind of feed.	Per 100 pounds of milk.		Per pound of butterfat.	
	1,214 records in 10 experiment station herds.	1,077 farmers' herds containing 22,836 cows.	1,214 records in 10 experiment station herds.	506 farmers' herds containing 11,890 cows.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Concentrates.....	34.9	28.7	8.1	7.2
Succulent feed.....	81.6	100.8	19.1	25.4
Dry forage.....	50.6	60.0	11.8	17.0

THE COST OF MILK BY FORMULA.

Of all the items entering into the cost of milk, feed is the largest. Labor is next. On 867 farms, including 17,459 cows, barn feed and human labor together constitute an average of 84.1 per cent of the net cost of production after all returns except milk were deducted from the charges. The other costs, such as pasture, bedding, horse labor, use of buildings, use of equipment, interest on cows, interest on feed and supplies, depreciation on cows, bull service, and miscellaneous charges, after credits for calves born during the year, manure, and miscellaneous credits were deducted, averaged 15.9 per cent.

It is at once apparent then how much influence is exerted by changes in the prices of feeds and in wages on cost of production. Using the quantities already given in Tables 2 and 3, the average cost of milk can be approximated by applying prices as follows:

Concentrates, 28.7 pounds, at \$0.025-----	\$0.72
Succulent feed, 100.8 pounds, at \$0.0035-----	.35
Dry forage, 60 pounds, at \$0.009-----	.54
Human labor, 2.6 hours, at \$0.30-----	.78
Feed and labor-----	2.39

Assuming feed and labor equal 84.1 per cent of net cost of milk, the total yearly net cost of milk per 100 pounds would be \$2.84.

While the yearly cost of milk may be approximated by the above method, the fact remains that in the grazing period the cost is much less than the yearly average cost, and in the winter period it is more. In Iowa in 1916-17 Munger found the cost of 100 pounds of milk while cows were on full pasture to be \$1.98, while on part pasture and part other feed it was \$3, and during the winter \$4. In New York the writer found the cost during the pasture season of 1914 to be \$0.93, and in the winter period \$2.41 per 100 pounds. The cost in winter is fully double the cost in the summer.

The cost of producing milk is not constant, but changes with the price of cows, price of feed, value of land, wages, interest rate, and many other items. The effect of changes in wages and in the prices of feed on cost of production for the areas previously reported would be as shown in Table 4. A change in cost of labor or feed, however, causes dairymen to modify their practices, and for this reason one can not accurately predict the effect on cost of production as a whole of a change in one item.

TABLE 4.—*Effect of changes in prices of feed and labor on cost of production if quantities of feed and labor used and production were same as average given in Table 2.*

If other conditions remained exactly the same, a change of—	Would change the cost of producing 100 pounds of milk—
	Cents.
\$1 a ton for concentrates.....	1.4
\$1 a ton for succulent feed.....	5.0
\$1 a ton for dry forage.....	3.0
1 cent an hour of human labor.....	2.6

SOME FACTORS INFLUENCING THE COST OF PRODUCING MILK.

In the broader aspects, the most important factors influencing milk costs are prices for the materials and effort used in production. These vary with regions and also with tendencies of the general price level of all commodities.

The increase in prices during the World War included cattle feed, labor, building materials, cattle, and interest rates. The cost of milk therefore increased. Now that prices of all these are reduced, or

are being reduced, the cost is lowered. It is not purposed in this paper to discuss these changes in price level on cost of production, but only to state in general for the United States that farm labor and pasture are more expensive in the Middle West, and concentrates and hay less valuable than in the eastern part of the country. These price relationships must be observed in any comparison of cost of production between regions, but the data concerning methods of production are so limited that it has been considered inadvisable to attempt to compute actual regional cost differences, or differences between the United States and other countries. Rather, under factors influencing the cost of milk production the following features of the organization of the dairy enterprise, or methods of feeding and handling are considered: (1) Size of business, (2) the cow, (3) time of freshening, (4) feeding practices, (5) value of offspring.

1. *Size of business.*—The best measure of the size of a dairy enterprise, generally, is the number of cows kept. There are very few herds of more than 60 cows, but many of from 20 to 40 cows. The most important respects in which a fairly large dairy results in a lower cost per unit of product are:

1. Less labor is required per animal.
2. Building charges are lower per animal.
3. Delivery charges are less per unit of product.
4. Buying feed or supplies in quantities effects savings.

The most important of these is the saving in labor which accompanies a large business, which is illustrated by data from one New York area, as shown in Table 5.

TABLE 5.—*Relation of size of herd to labor charge per unit of product, Broome County, N. Y.*

Number of cows per farm.	Hours of labor.		Labor charges per 100 pounds of milk at various rates per hour.			
	Per cow.	Per 100 pounds of milk produced. ¹	15 cents.	20 cents.	30 cents.	40 cents.
8.6	217	3.98	\$0.60	\$0.79	\$1.19	\$1.59
12.4	199	3.73	.56	.75	1.12	1.49
16.1	184	3.45	.52	.69	1.04	1.38
23.3	161	2.75	.41	.55	.82	1.10
Difference between 9-cow and 23-cow herds.....			.19	.24	.37	.49

¹ Including time for hauling milk.

The facts that many farms were laid out before the development of machinery, and are, therefore, generally too small now for most efficient operation; and that the age at which the majority of farmers get these farms paid for is past 40 years; and further, the need of considerable capital and credit under present conditions of high-priced land, equipment, and cattle, for enlarging the business, operate to keep most dairy farms of a size smaller than would permit of most economical production of milk.

The following data for a strictly dairy region in New York State gives the variations in the size of business, in terms of cows and number of men on a year basis, for 83 farms. The average number of cows per farm was 24.8, the average number of men 2.02.

TABLE 6.—*Variation in size of business on 83 farms in Chenango County, N. Y., 1921.*

Number of men on a year basis.	Number of farms with indicated number of cows per farm.			
	Less than 18 cows.	18 to 30 cows.	Over 30 cows.	Total.
1.0 to 1.4.....	14	9	0	23
1.5 to 1.9.....	6	4	2	12
2.0 to 2.4.....	4	18	10	32
2.5 to 2.9.....	0	2	7	9
3 and over.....	0	0	7	7
Total.....	24	33	26	83

It is evident from the table that half the farms with over 30 cows have less than 2.5 men, including the operator. A two or three man business produces efficiently.

2. *The cow.*—A vast amount of discussion, accompanied by much tabular data, has been presented to show the influence of high-yielding cows in lowering the cost of milk. But yield is a result, and to learn much about the causes of this result and, therefore, the causes of the lowered cost, one must go deeper than production cross tabulations.

The experiment station, if it is to serve the interest of the dairy farmer, must be in a position to tell him something more than the facts that good-yielding cows pay best, and that the way to know which are the good ones is to use the scales. The first he knows full well, and for the last he is too busy. Farm management surveys generally have not gone deeper than to point out the relation between yield and cost of milk or labor income. The practical farmer desires to know how to organize his business, and how to feed his herd to make more money, and this involves more than simple statements that good yields pay. However, to illustrate the influence of yield per cow on cost, Table 7 is given.

TABLE 7.—*Showing the relation of production per cow to cost of production, on 149 farms, with 2,058 cows, Broome County, N. Y., 1915.*

Range of milk production per cow for the group.	Average milk produced per cow.	Cow cost of milk per 100 pounds.	Cost of milk in each group compared with the average of all the farms.	Relative cow cost, taking first group as 100.	Decrease in cow cost below preceding group.
	<i>Pounds.</i>				
Under 4,500 pounds.....	4,063	\$2.00	+\$0.31	100	.....
4,500 to 5,500 pounds.....	4,961	1.75	+.06	88	\$0.25
5,501 to 6,500 pounds.....	5,916	1.63	-.06	82	.12
Over 6,500 pounds.....	7,136	1.61	-.08	80	.02

Thus the effect of increased yield in lowering the cost may be seen, but also the decrease in cost of production diminishes as the yield increases, chiefly because more intensive methods are necessarily used to obtain the increased amounts of milk. Proper allowance should be made for the costs having been taken before the great war.

The writer finds the coefficient of correlation between the pounds of milk produced per cow per year for 4,136 cows on 163 New York farms and the cost of producing 100 pounds of milk, to be -0.480 ± 0.041 , indicating the pronounced influence of high yields in lowering production costs. The greater efficiency made in the use of feed by high-yielding cows is well known and is indicated by a correlation between the pounds of milk produced per cow per year and the pounds of milk produced per 100 feed units, of $+0.677 \pm 0.014$.¹

But the difference in yield between groups of herds, or between cows, is due in part to physical characteristics of the animals as well as to differences in method of handling. The most interesting question is, therefore, what are the factors responsible for variations in yields?

(a) *Size of cow*.—One of the first of the physical differences is size. Two things are to be considered in relation to the most efficient size of cow—topography of the pasture and the use of barn feed. Small cows and small breeds make the most efficient use of steep, rugged pastures, but large cows of a large breed make the most efficient use of barn feed. The facts are that our larger dairy breeds are found in greatest numbers, and the evidence seems to be that the well-grown, better-sized cows of these breeds are more economical producers than the smaller animals.

In support of this, the weight of cows on some Illinois farms was found by Pearson¹ to be correlated with the pounds of milk produced annually per cow by a coefficient of $+0.304 \pm 0.024$; and with the fat produced per cow per year, by a coefficient of $+0.243 \pm 0.025$. The writer finds the average weight of herds on 163 farms in Herkimer County, N. Y., to exhibit a coefficient of correlation with the cost of producing milk, of -0.190 ± 0.051 , indicating that to some degree the larger cows produce more economically.

The size and conformation of a cow is to some extent indicated by length of back, length of rump, and circumference of heart girth, as well as by weight. Pearson found the relation between these three features and milk produced annually for a large number of cows to show coefficients of correlation, respectively, as follows: Length of back, $+0.345 \pm 0.029$; length of rump, $+0.091 \pm 0.033$; and circumference at heart girth, $+0.329 \pm 0.029$. This again simply shows the larger cows to be greater producers.

Dana, at Vermont, found the relation of the length of the cow's body for 612 cows to show a correlation coefficient of $+0.376 \pm 0.023$ with the length of the milk-vein system; and the length of the veins to show a correlation of $+0.211 \pm 0.042$ with the milk yield.²

Without much question, the conclusion is correct, that the large cows produce more, make more efficient use of feed, and produce

¹ Data gathered by F. A. Pearson. Permission to publish this, and succeeding Illinois data, granted by the University of Illinois and Doctor Pearson.

² Vermont Bul. 202. Aldrich, however, found no correlation between length of veins and milk yield.

more economically when all items of cost are considered, than do smaller ones. Size of cow, therefore, is one factor influencing milk costs, but not so important as many other factors, but the extent of the advantage of having large animals depends upon the topography. The term "capacity" is often used to express all of those characteristics of a dairy cow which indicate that she has inherent tendencies to make most efficient use of feed and respond to favorable handling conditions. Cows with capacity result from breeding and proper feeding and care from birth.

(b) *Age of cow*.—Heifers in the first three lactation periods are still growing and developing, and produce neither so much nor so economically as do mature cows. It therefore follows that the more animals of mature age found in the herd, the lower the cost of milk. The age at which cows generally produce their maximum has been studied by several, and the best résumé of the research on this point is Iowa Research Bulletin No. 73, by McCandlish. Practically no study of this question has been made with average-run farmers' herds, all having been with cows in experiment stations' herds, or farmers' cows having advanced-registry records. The data obtained indicate that generally the maximum production is reached at 6 to 8 years of age, but varies with the different groups of animals studied. A sufficient number of cow-testing association records of farmers' animals are available to furnish more information on this question for cows under farm conditions.

The writer has studied this question, not from the standpoint of the production of individual cows as related to age, but from the relation of average herd yields to the proportion of the herd comprising cows of mature age, 5 to 8 years old. There is evidence on the farms studied that the largest yields result, and the production costs are cheapest, when a large proportion of the cows are of mature age. This takes account of the increased depreciation accompanying the older animals. The reason is not so much that the cows older than 8 years are not good yielders, as it is to low yields of 2 and 3-year-old heifers. McCandlish, in a study of 10,308 Jersey and Guernsey official records reported in Iowa Research Bulletin No. 73, showed the 2 and 3-year-old milk records to be 76 to 86 per cent of the 5-year-old records.³

The farmer can never apply information as to the age of maximum production for any group of cows to individual cows in his herd. At exactly what age a particular animal is at its best may not be in accord with a group average. He can, however, apply to the organization of his herd the established principle that, in general, mature cows yield heaviest and produce milk cheapest, and that the larger the proportion of the herd he maintains at mature age the higher will be the yield, thus resulting in a lowered cost.

3. *Time of freshening*.—The season of the year in which most of the cows in a herd freshen has much to do with yield and with cost of production. Cows that freshen in early autumn produce more for the year, and considerably more in the winter, than spring-fresh cows. On 163 farms in New York the writer found the coefficient of correlation between the per cent of cows freshening from September

³ McCandlish, A. C., Influence of age at the time of freshening on production of dairy cows. Iowa Research Bul. 73.

to December, inclusive, and the milk produced in the winter period to be $+0.602 \pm 0.034$. But he also found the correlation between the narrowness of the winter ration and the per cent of cows freshening in the fall months to be -0.317 ± 0.048 . That is, dairymen with fall-fresh cows feed narrower rations. Also the fall-fresh herds comprise a larger proportion of cows of mature age than spring-fresh herds.

The question, therefore, arises as to how much of the better yield in the winter period is actually due to the fact that the animals freshened in the fall, how much to the fact that they received higher protein rations, and how much to the fact that a larger proportion of the cows were of prime age. This can be answered approximately by partial correlation; and the coefficient of partial correlation between fall freshening and winter-period yield, with the influence of narrowness of winter ration eliminated, is $+0.540 \pm 0.037$, indicating a very high degree of relationship.

The relation of time of freshening to yield and to cost of production is shown in Table 9.

TABLE 9.—*Relation of season of freshening to yield of milk per cow and cost of production, Chenango County, N. Y., 1921.*

Per cent of cows freshening from September to December, inclusive.	Number of farms.	Number of cows.	Number of cows per farm.	Milk produced per cow.	Average weight of cows.	Average per cent of cows freshening from September to December, inclusive.	Cost of producing 100 pounds of milk.	Returns per hour of labor above other costs.
				<i>Pounds.</i>	<i>Pounds.</i>			
Less than 25.....	29	635	22	4,980	883	11.3	\$2.86	\$0.025
25 to 50.....	36	912	25	5,042	906	38.2	2.91	.....
Over 50.....	18	526	29	6,025	950	61.9	2.35	.124

The difference in yield between herds with 11 per cent of the cows fall fresh and herds with 62 per cent was 1,045 pounds of milk. The cows in herds that freshened in the spring were smaller, and the herds were smaller. Probably not all of the 1,045 pounds difference in yield is due to the season of freshening, although this must be considered an important factor affecting yield of cows and cost of milk.

4. *Feeding practices.*—At least two characteristics of dairy rations seem to have an important relation to milk yields and the cost of production. One is the protein intake, indicated by narrowness of the ration, and the other is the proportion of the energy or nutriment derived from concentrates, from succulent feed, and from dry forage.

(a) *Narrowness of ration.*—The index number commonly used to express proportionate protein content or narrowness of rations has been the nutritive ratio. The writer has used a different index, the protein-energy ratio,⁴ which is the relation of the pounds of digestible protein to the therms of net energy in the ration. The relation of narrowness of ration to milk yield, fat yield, fat test, cost of

⁴ Cornell University Memoir 64.

production, and profit per cow in various regions is shown in Table 10.

TABLE 10.—*Relation of narrowness of ration to production of cows, cost of milk production, and profit per cow.*

Subject.	Relative.	Coefficient of correlation "r"
Protein-energy ratio.....	Milk produced per cow per year.....	-0.389 ± 0.045
Do.....	Milk produced per cow in winter period.....	-0.523 ± 0.038
Do.....	Cow cost of milk per 100 pounds, Herkimer County, N. Y.....	$+0.253 \pm 0.049$
Do.....	Cow cost of milk per 100 pounds, Broome County, N. Y.....	$+0.241 \pm 0.052$
Do.....	Profit per cow, Herkimer County.....	-0.300 ± 0.048
Do.....	Profit per cow, Broome County.....	-0.333 ± 0.049
Do.....	Milk produced per cow per year (with a constant amount of seasonal distribution of production).	-0.247 ± 0.050
Do.....	Milk produced per cow in winter period (with a constant amount of fall freshening.)	-0.439 ± 0.043
Nutritive ratio ²	Milk produced per cow per year.....	-0.419 ± 0.022
Do.....	Fat produced per cow per year.....	-0.405 ± 0.022
Do.....	Butterfat test of milk.....	$+0.016 \pm 0.027$

¹ Coefficients of partial correlation.

² Furnished by F. A. Pearson for some Illinois farms.

Since, as previously stated, the tendency to have animals freshen in the fall and to use narrow rations is associated, the narrowness of ration when related to milk yield in the winter period shows a partial coefficient of correlation of -0.439 ± 0.043 if the influence of fall freshening is eliminated. This is somewhat less than the direct coefficient. The narrowness of the winter ration as expressed by protein-energy ratio shows a correlation with the cost of producing milk of $+0.253 \pm 0.049$ for one area in New York and $+0.241 \pm 0.052$ for another. The correlation of this factor with profit per cow was -0.300 ± 0.048 and -0.333 ± 0.049 , respectively.

The actual data on relation of yield and of cost of milk production for cows receiving narrow and wide rations in one area of New York State are shown in Table 11.

TABLE 11.—*Relation of narrowness of winter ration to yield per cow (163 farms, 4 136 cows). Herkimer County, N. Y., 1919.*

Protein-energy ratio.	Number of farms.	Number of cows.	Milk produced per cow.	Decrease in production per cow under preceding group.	Cow cost of milk per 100 pounds.	Loss per cow.
			Pounds.	Pounds.		
Less than 6.....	14	397	6,334	.....	\$3.34	\$12.00
6 to 7.5.....	70	1,892	5,454	880	3.46	23.00
Over 7.5.....	79	1,847	4,637	817	3.84	41.00

(b) *Derivation of energy or nutrients.*—The second feature of rations which seems to have considerable influence on yield, cost of production, and net returns is the proportion of the energy or nutrients derived from each of concentrates, succulent feed, and dry forage.

With fall-fresh cows—that is, winter dairying—a considerable proportion of energy from succulent feed increases yield, decreases

cost of production per unit, and increases profits. With a large proportion of spring production, the advantages of succulent feed in the winter ration are less.⁵ The economic advantages of a silo depend upon the size of the herd and whether or not the winter system is followed. Since corn supplies so much nutrients per acre, the dairy man growing silage can do more business on a given area by supporting more cows. With largely winter dairying, the writer found the cost of production to be 9 per cent higher when no silage was used than when silage was used; and in summer dairies when no silage was used, 14 per cent less than when silage was used. In winter dairies the gain was \$9 per cow in favor of silage, and in summer dairies \$9 per cow in favor of no silage.⁶

Also under farm conditions a large proportion of the nutriment from concentrates results in increased yields of pounds of milk, approximately equal to the increased pounds of concentrates used. This statement would not apply generally, but appears to be the case with farmers' herds. A large proportion of the energy from concentrates results in enough higher yield per cow to reduce the cost per unit and increase the gains.⁷

The relation of the intensiveness of winter feeding, and the proportion of the energy from concentrates, to production and gain or loss per cow in one New York area is shown in Table 12.

The intake of energy per cow varies on practical farms, as does also the proportion of energy derived from concentrates, silage, and hay. The lower intakes of energy are due to smaller animals, and to less intensive feeding. On 149 farms in Broome County, N. Y., the average yield for the year of cows receiving less than 2,400 therms (in the winter ration) was 5,043 pounds of milk; for cows receiving 2,400 to 3,000 therms, 5,477 pounds; and for cows receiving over 3,000 therms, 5,846 pounds of milk per cow.

TABLE 12.—*Relation of intensity of winter feeding and proportion of the energy of the winter ration in grain to production and profits.*

Therms per cow in winter ration.	Per cent found in grain, of the therms in winter ration.	Number of farms.	Number of cows.	Cows per farm.	Therms in winter ration.			Pounds of milk produced per cow.	Profit or loss per cow.
					Total per cow.	In grain per cow.	Per cent in grain.		
Less than 2,400.	Less than 25.....	9	116.0	12.9	2,201	446	20.3	4,853	+\$3
	25 to 35.....	19	290.5	15.3	2,142	642	30.0	5,166	+9
	Over 35.....	7	79.0	11.3	2,175	893	41.0	4,871	+10
	Totals and averages.	35	485.5	13.9	2,161	636	29.4	5,043	+8
2,400 to 3,000.	Less than 25.....	13	167.0	12.8	2,622	556	21.2	4,803	-9
	25 to 35.....	26	348.5	13.4	2,682	813	30.3	5,605	+1
	Over 35.....	13	175.0	13.5	2,635	1,086	41.2	5,864	+8
	Totals and averages.	52	690.5	13.3	2,657	820	30.9	5,477	0
Over 3,000.	Less than 25.....	22	313.5	14.2	3,933	803	20.4	5,542	-18
	25 to 35.....	21	275.5	13.1	3,674	1,074	29.2	5,868	-8
	Over 35.....	19	293.0	15.4	3,539	1,390	39.3	6,149	-6
	Totals and averages.	62	882.0	14.2	3,721	1,083	29.1	5,846	-11

⁵ Cornell University Agr. Exp. Sta. Bul. 409, p. 379.

⁶ Ibid., pp. 377-378.

⁷ Cornell Bul. 409, pp. 370-371.

Since relatively large proportions of the energy of a ration in concentrates and in succulent feed gives higher yields and lower cost, it would be expected that the larger proportion of energy in dry forage would result in lower yield, higher cost of milk, and greater losses. This was true in the only area which the writer has studied in this respect. See Table 13.

TABLE 13.—*Relation of season of milk production and proportion of energy of the winter ration in dry forage, to production, cost of production, and profits.*

Milk sold during May, June, and July (per cent).	Therms in winter ration in dry forage.	Number of farms.	Number of cows.	Milk produced per cow.			Cow cost of milk per 100 pounds.	Profit or loss per cow.	Value of feed except pasture per cow.	Pounds of milk produced per dollar's worth of feed, except pasture.	
				Total for year.	October to April, inclusive.	May to September, inclusive.				Year.	Winter.
	<i>Per cent</i>			<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>					
Less than 33..	Less than 40....	18	345.0	6,192	3,861	2,331	\$1.65	+\$5	\$52	96	62
	40 to 65.....	22	274.0	5,750	3,009	2,741	1.90	—10	62	93	49
	Over 65.....	16	179.0	5,216	3,017	2,199	2.01	—14	55	94	54
33 to 40.....	Less than 40....	12	202.5	5,480	2,633	2,847	1.65	—1	53	103	50
	40 to 65.....	26	346.0	5,549	2,675	2,874	1.66	—3	51	109	52
	Over 65.....	14	208.5	4,532	2,329	2,203	1.83	—2	76	111	57
Over 40.....	Less than 60....	11	141.5	5,264	2,073	3,191	1.74	+5	45	117	46
	60 to 75.....	20	262.0	5,424	2,103	3,321	1.42	+6	41	133	52
	Over 75.....	10	99.5	4,797	1,670	3,127	1.57	—1	39	122	43

5. *Value of offspring.*—One of the credits made before determining the net cow cost of milk production is the value of calves at birth. In grade herds, calves have a low value at birth. In purebred herds the value at birth may be very little above grade values, or for highly bred animals may be so much that the cost of producing milk may be very little. The value of purebred animals is determined chiefly by the advanced-registry record of the animal or by the records of its immediate ancestry. The relationship of these points to selling values of Holstein cattle is shown in Tables 14 to 16.^s

TABLE 14.—*Relation of A. R. O. records to prices received for 55 Holstein females, Syracuse, N. Y., 1919.*

Best A. R. O. 7-day butter record of animal.	Number of animals sold.	Average price received per head.
Less than 15 pounds.....	12	\$400
15 to 20 pounds.....	19	478
20 to 25 pounds.....	13	610
25 to 30 pounds.....	8	762
Over 30 pounds.....	3	1,467

^s Holstein-Friesian World, Jan. 8, 1921. Article by author.

TABLE 15.—*Relation of number of A. R. O. dams in 4 generations to prices received for 118 Holstein females without A. R. O. records, Syracuse, N. Y., 1919.*

Number of A. R. O. dams in 4 generations.	Number of animals sold.	Average price received per head.
1.....	2	\$195
2.....	6	196
3.....	11	265
4.....	18	234
5.....	20	282
6.....	25	377
7.....	36	454

TABLE 16.—*Relation of number of dams in 4 generations with seven-day butter records of over 30 pounds, to prices received for Holstein females, Syracuse, N. Y., 1919.*

Number of dams in 4 generations with records of over 30 pounds in 7 days.	Females with A. R. O. records.		Females without A. R. O. records.		All females.	
	Number sold.	Average price per head.	Number sold.	Average price per head.	Number sold.	Average price per head.
None.....	22	\$396	38	\$240	60	\$297
1.....	11	768	26	229	37	389
2.....	12	573	27	361	39	426
3.....	7	801	18	454	25	551
4.....	2	830	8	799	10	806

From these tables it may be seen that selling values are closely related to A. R. O. backing. Therefore in purebred herds, particularly of Holsteins, the value of calves at birth and consequently the effect of this value in lowering the cost of producing the milk, will depend largely upon the records of the ancestors.

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MILCHERZEUGUNG—MILCHVERWERTUNG.

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Die Frage der Milchversorgung grösserer Verbrauchszentren mit einwandfreier Milch ist ganz besonders in der Kriegszeit so recht in den Vordergrund getreten und Stadt und Land haben die Wichtigkeit dieses für unsere gesammte Volkernährung unentbehrlichen Nahrungsmittels, man könnte sagen, am eigenen Leibe verspürt.

Ich entledge mich nun gerne meiner mir gestellten Aufgabe, über Milcherzeugung—Milchverwertung meine Ansicht, vom Standpunkte hierortiger Verhältnisse betrachtet, niederzulegen.

Kuhmilch ist das normale Produkt der Milchdrüsen der weiblichen Säugetiere und wird, falls im natürlichen Zustande in Verkehr gebracht, kurzweg Vollmilch genannt. Die genaue chemische Untersuchung normaler Vollmilch hat ergeben, dass dieselbe vor allem bei 15° C. ein spezifisches Gewicht von 1.029 bis 1.032 haben soll, desweiteren enthält die Milch annähernd 87 Prozent Wasser, dann MilCHFett als Tagesdurchschnitt mindestens 3.2 Prozent; ferner Casein, Albumin, MilChzucker und Mineralbestandteile. Was den Fettgehalt anbetrifft, so betone ich da ausdrücklich, dass Schwankungen, sei es nach aufwärts oder abwärts, nicht selten vorkommen, denn die Fütterung, ebenso die Rasse der Tiere und so vieles andere ist hier von ausschlaggebender Bedeutung.

Wie vorhin gesagt, enthält die Milch nicht nur Fett, vielmehr auch Eiweiss, MilChzucker, und Mineralbestandteile. Lenken wir nur einen Blick in die fachärztliche Zeitschrift über Kinderernährung,

so finden wir darin, dass immer und immer wiederum in erster Linie die Mutterbrust, welche das natürliche Produkt für die Ernährung unserer Säuglinge hingestellt wird und dieser Gedanke muss jeder anderen Bewegung vorangestellt werden. Erst dort wo die Mutterbrust zur Gänze versagt oder nicht ausreicht, wird ein Ersatz für Muttermilch empfohlen. Als solcher kann aber meines Erachtens nur eine einwandfrei gewonnene Kuhmilch in Betracht kommen und in dieser Beziehung glaube ich mit den Herren Aerzten einig zu sein.

Eine Vergleichstabelle über den mittleren Fettgehalt der Frauenmilch und der Kuhmilch besagt deutlich, dass ein gewaltiger Unterschied in der Zusammensetzung beider Milchen nicht vorliegt; kein Wunder daher, wenn von den berufenen Stellen auch Kuhmilch als der beste Ersatz für die Muttermilch hingestellt wird. Die feine Verteilung des Fettes, die der Nährsalze, der angenehme Geschmack und die vielseitige Verwendungsmöglichkeit machen daher die Milch zum unentbehrlichsten Nahrungsmittel und es ist daher nur zu begreiflich, wenn bei mangelnden Vorräten—wie dies eben im letzten Kriege der Fall war—die Behörden bemüht waren, vorerst den notwendigen Bedarf für Säuglinge, stillende Mütter und Kranke sicherzustellen.

Wir sehen also, dass in der Ernährungspolitik die Frage der Milchbeschaffung eine nicht minder wichtige Rolle spielt und zumindest ebenso wichtig zu sein scheint, wie jene der Fleisch und Kartoffelbeschaffung. Zu der Erkenntnis, dass die Milch zu den unentbehrlichsten Nahrungsmitteln gezählt werden muss, ist man so recht erst in der Kriegszeit gelangt. Der Krieg mit seinen gewaltigen Begleiterscheinungen hat auch in der Milcherzeugung, Milchbeschaffung und -Verwertung Verhältnisse hervorgerufen, durch die nicht nur die Milcherzeuger, vielmehr der allgemeine Versorgungsplan und schliesslich die Molkereigrossbetriebe selbst, in Mitleidenschaft gezogen wurden.

Es ist eine bekannte Tatsache, dass wir alle im Kriege unter Milchmangel zu leiden hatten, denn selbst die Milchreiche Schweiz, in der Nähe zu ein Liter Milch auf den Kopf der Bevölkerung in Friedenszeiten entfiel, sah sich infolge des ständigen Rückganges in der Produktion zu gesetzlichen Massnahmen, als wie Beschränkung des direkten Verbrauches, dann der Käsefabrikation und schliesslich der Ausfuhr von Kondensmilch, genötigt.

Die Ursachen dieses Milchmangels sind wohl zur Genüge bekannt, ich will sie aber trotzdem nochmals kurz streifen. Der Milchmangel wurde hervorgerufen vor allem durch die stetig verringerte Zahl von Melktieren, dann durch Mangel an Kraftfutter, sowie Futter überhaupt und schliesslich durch den Mehrverbrauch im Haushalt des Produzenten. Die Zahl der Melkkühe hat bei unseren Landwirten deshalb abgenommen, weil ihnen vielfach das nötige Futter fehlte und weil desweiteren die Heeres-Verwaltung und ebenso auch die Zivilverwaltung ohne Rücksicht auf milchtragende oder nichttragende Kühe Lieferungsaufträge zudiktiert wurden, die eben dann unbedingt und prompt erledigt werden mussten. Es fehlte dann auch noch an Kraftfutter, Kleie und Kartoffeln; gerade der Mangel an Kartoffel trug eben auch dazu bei, dass im Haushalte des Produzenten mehr Milch als bisher verkonsumiert wurde.

Nicht unerwähnt kann ich noch lassen, dass das Preisverhältnis der Milch nicht immer das richtige war. Die Behörden bemühten sich eben, billige Milch den Konsumenten zur Verfügung zu stellen, doch auf der anderen Seite wurde eben durch die Niedrighaltung der Preise die Produktion gehemmt und die Forderung nach Erhöhung des Milchpreises muss daher als Selbsterhaltungstrieb immer und immer wiederum gewertet werden.

Volksernährung, Volksgesundheit war bereits gefährdet, es war daher ein Gebot der Notwendigkeit, dass gleich nach dem Kriege Massnahmen getroffen wurden, die ein weiteres Zurückgehen der Produktion unmöglich machen sollten. Erfreulicherweise hat nun die Milchproduktion innerhalb der letzten zwei bis drei Jahre zusehend zugenommen und sind wir jetzt, und da glaube ich nicht zu übertreiben, wenn ich sage, allerorts in der glücklichen Lage, nicht nur jene Milchmengen sicherzustellen, die für den notwendigsten Bedarf bestimmt sind, vielmehr können wir auch jetzt wiederum zur teilweisen Verarbeitung auf Butter, Rahm und den sonstigen Milcherzeugnissen übergehen.

Mit der Produktion in innigem Zusammenhange stehen Güte und Qualität der Milch und glaube ich, auch darüber einige Worte verlieren zu müssen. Die Qualität der dermalen aufgelieferten Milch lässt bedauerlicherweise bei vielen unserer Milcherzeuger so manches zu wünschen übrig. In meiner Eigenschaft als ständig gerichtlich beeideter Molkerei-Sachverständiger habe ich nicht selten Gutachten über abschwebende Strafprozesse wegen Milchverfälschung abzugeben und leider häufen sich in der letzten Zeit solche Fälle zusehends. Unberechenbar sind die Schäden, welche unserem Volksganzen daher auch den Molkereibetrieben entsehen, wenn nicht vollwertige Milch zur Ablieferung gebracht wird und muss daher die Forderung nach Bezahlung der Milch dem Wertgehalte derselben, das heisst also, die sogenannte Fettgehaltsbezahlung als dringend notwendig bezeichnet werden. Hierbei würde es sich auch empfehlen, von Seite der Behörden auf einwandfreie Milcherzeugung sowie Milchgewinnung mit allen Nachdruck hinzuarbeiten, und so entsprechende Kontrollmassnahmen in die Wege zu leiten.

Bis nun wurde die Milchgewinnung, vom Standpunkte der Verbraucher betrachtet, als Stiefkind behandelt, weshalb die Forderung, die massgebenden Behörden sollten der Milchgewinnung und dem Milchverkäufe ihr Hauptaugenmerk zuwenden, mit allen Nachdruck zu unterstützen wäre.

Die Herausgabe eines besonderen Milchregulativs für jede Stadt scheint mir als wirksamstes Mittel gegen unerlaubte Milchmanipulationen zu sein, wenngleich ein Milchregulativ ohne Vornahme behördlicher Kontrollmassnahmen einen Erfolg gleichfalls kaum erwarten lässt.

Wie bereits von mir an früherer Stelle erwähnt, bildet die Kuhmilch den besten Ersatz für Muttermilch. Sie enthält nachweisbar alle Bestandteile, die für den Körperbau des Menschen und hier in erster Linie des Säuglings von ausserordentlicher Wichtigkeit sind und um damit die Kuhmilch in ihrer gesamten Vollwertigkeit dem Konsum zugeführt werden kann, müssen wir trachten, die Erzeuger hierfür zu gewinnen. Die Milch soll aber nicht nur vollwertig, vielmehr auch gut sein. Die für den Konsum bestimmte Milch soll daher von

gesunden Kühen stammen und ausser den bekannten Grundsätzen der Stallhygiene ist besonders darauf zu achten, dass zur Pflege und Wartung der Milchtiere Personen herangezogen werden, die an keiner ansteckenden Krankheit leiden. Reinlichkeit im Stall, Reinlichkeit der Milchtiere und Reinlichkeit des Stallpersonals, sind die Grundbedingungen bei der Gewinnung einwandfreier Milch, ganz besonders sollte man aber auf jene Milch das Hauptaugenmerk richten, die für Säuglinge und stillende Mütter, sowie Kranke bestimmt ist. Für diese Milchbedürftigen sollte nach Tunlichkeit eine Milch in Betracht kommen, die vermöge ihrer Behandlungsweise auch als Vorzugsmilch gewertet werden könnte.

Eine solche Vorzugsmilch—Kindermilch auch Kurmilch genannt—müsste von Tieren stammen, die fallweise einer tierärztlicher Kontrolle, sowie Tuberkelimpfung unterzogen wurden, wo alle krankheitsverdächtigen Tiere durch gesunde immer ersetzt werden müssten und wo desweiteren auf gute Wartung und Pflege besonders geachtet und unter gewissen Voraussetzungen nicht nur ermolken, vielmehr auch alle übrigen Vorrichtungen im Stalle vorgenommen werden würden. Die auf diese Weise genommene Milch müsste dann gereinigt und tiefgekühlt werden und käme entweder als Rohmilch in Verkehr oder aber sie würde vor dem Verkaufe eine Hoch- oder Dauerpasteurisierung untergezogen werden.

Zur Vermeidung von Milchkrankheiten und Milchfehlern, muss die Milch unter allen Umständen in einer möglichst reinen und keimfreien Weise gewonnen werden und dazu gehört wohl vor allem eine rationelle Stallwirtschaft.

Wollen wir nun Milch bekommen, wie wir solche für unsere Volksernährung benötigen, dann müssen wir uns andererseits auch bemühen und trachten, unsere Milcherzeuger hierzu zu gewinnen. Aus diesem Grunde sollen wir allen berechtigten Wünschen derselben nachkommen, ebenso müssen wir aber auch dafür sorgen, dass wir genügend geschultes Personal zur Verfügung haben; es müssten daher sogenannte Melkerkurse abgehalten werden, wie nicht minder in landwirtschaftlichen Schulen—in den Molkerei-Schulen geschieht dies ohnedies—durch geeignete Vorträge unser künftiges Melker- und Molkepersonal über die Wichtigkeit einer rationellen Milchwirtschaft und Milchverwertung zu belehren und für die Zukunft entsprechend vorzubereiten. Mit der Hebung der Milchproduktion steigt auch das Wohl unserer gesamten Landwirtschaft, denn Milchwirtschaft steht mit der Landwirtschaft im innigen Zusammenhange und wenn diese beiden Faktoren erspriessliches zu leisten in der Lage sind, dann können wir auch mit einer Bestimmtheit auf einen gewissen Wohlstand im Staate hinweisen.

Die vielfache Verwendungsmöglichkeit der Milch macht dieselbe zum unentbehrlichsten Nahrungsmittel und mit diesen Worten übergehe ich zur Besprechung der verschiedenen Arten der Milchverwertung.

In einer Molkerei Deutschlands las ich folgendes schön verfasste Sprüchlein:

„Wer Milch verfälscht, mit Wasser tauft,
Ist wert, dass er sie selber sauft!“

darunter stand weiter:

„Am längsten währt die Ehrlichkeit,
Abrahmen ist eine Schlechtigkeit!“

Dieses kurze, sinngerechte Sprüchlein besagt vieles. Vor allem kommt die Milch als Frischmilch, sogenannte Trinkmilch in Betracht; es muss daher jede Verfälschung hintangehalten werden, wie nicht minder jeder Versuch, Milch zu verfälschen oder gar mit Wasser zu versetzen, rücksichtslos zu bestrafen wäre. Schon bei Erörterung der Frage der Milcherzeugung habe ich ganz besonders darauf hingewiesen, dass die Kuhmilch als vollwertiger Ersatz der Muttermilch angesehen werden kann und finden wir daher hier die erste, aber auch bedeutungsvollste Art der Verwendungsmöglichkeit. Die Milch wird desweiteren dann auch gerne von den Grossen begehrt und nicht jeder Haushalt ist in der glücklichen Lage, Rahm oder Obers zu beziehen. Gerade in den Sommermonaten spielt Frischmilch als Trinkmilch bei der Bevölkerung eine wesentliche Rolle, wovon wir uns bei einem Besuche einer Sommermilchtrinkhalle oder eines Milchpavillons bei einer Ausstellung überzeugen können; allerdings kommt auch hier wiederum nur unverfälschte Milch in Betracht. Desweiteren herrscht im Sommer lebhaftere Nachfrage nach saurer Milch im Verein mit einem Stückchen Butterbrot ein herrliches Gericht.

Eine andere Verwertungsmöglichkeit der Milch liegt in den Worten: "Abrahmen ist eine Schlechtigkeit." Der Erzeuger ist also verpflichtet, die Milch in natürlichen Zustande, daher als Urprodukt dem Konsum beziehungsweise den Grossmolkereien zuzuführen. Nachdem die Milch nicht nur Eiweiss, vielmehr auch Milchfett enthält, so ist es nur zu begreiflich, dass das Milchfett bei der Verwertung gleichfalls eine wesentliche Rolle spielt.

In dem Augenblicke, wo genügend Süssmilch als Frischmilch für Konsum zur Verfügung steht, sehen sich die Grossmolkereien genötigt, zur Milchverarbeitung überzugehen, wohingegen alle jene Molkereibetriebe, die ausserhalb einer erreichbaren Eisenbahnlinie liegen, wohl das ganze Jahr genötigt sind, Milch zu verarbeiten. Für die städtlichen Molkereigrossbetriebe kommt allerdings die Milchverarbeitung mit Beginn der Grünfütterung in Betracht, da um diese Zeit das Anlieferungsquantum um nahezu 30 bis 40 Prozent steigt; es muss daher alle unverkaufte Milch der Verarbeitung zugeführt werden und es beginnt in diesen Augenblicke die Milchzentrifuge beziehungsweise der Separator intensiv zu arbeiten.

Je nach örtlichen Verhältnissen wird entweder ein Teil von Rahm oder Obers als solcher mit verschiedenem Fettgehalt (zwischen 7 und 29 Prozent) und mit mannigfacher Bezeichnung als wie Schlagobers, Schlagsahne, Teeobers, Kaffeesahne in Verkehr gesetzt, der übrige Rahm hingegen wird auf Butter verarbeitet. Nur nebenbei will ich noch bemerken, dass ein Grossteil von Milch auch auf Kondensmilch oder Trockenmilch verarbeitet wird und auf diese Angelegenheit werde ich noch zu sprechen kommen.

Im Kriege musste allerdings die Buttererzeugung fast vollkommen stillgelegt werden, nachdem eben das verfügbare Milchquantum kaum für Säuglinge und stillende Mütter notwendig war. Nun ist aber genügend Aussicht vorhanden, dass die Verhältnisse auf allen Gebieten unseres Wirtschaftslebens, daher auch in der Milchwirtschaft sich bessern werden und deshalb werden auch jetzt wiederum die Molkereien wie vor dem Kriege der Butterqualitätsunterschiede nähertreten müssen. Nur jene Butter kann den Vorrang geniessen,

die erwiesenermassen unter Beobachtung aller hier in Betracht kommenden Anforderungen fachlicher Natur, hergestellt wurde. Bei der Butterherstellung ist darauf zu achten, dass der hierzu verwendete Rahm entsprechend pasteurisiert, tiefgekühlt und mit Rahmsäurekulturen angesäuert werde. Bei der Verarbeitung muss dann ferner auf die richtige Butterungstemperatur gesehen werden, wie nicht minder ein allzulanges Kneten die Qualität stark beeinflusst.

Zur Erreichung hochwertiger Buttererzeugnisse empfiehlt es sich, fallweise Butterschauen zu veranstalten, wo von gewiegten Fachleuten, die von den Molkereien eingesandten Butterproben genau untersucht und entsprechend klassifiziert werden und desweiteren zur Abstellung aller festgestellten Uebelstände dem Molkereipersonal Richtlinien zwecks Erreichung verzüglicher Ware gegeben werden.

Bei solchen Butterschauen, die vom Ackerbau-Ministerium oder Landwirtschafts-Ministerium einzuberufen wären, müssten naturgemäss auch alle jene Butterproben, die zumindest das Prädikat "fein" erhalten, mit entsprechenden Ehrenpreisen bedacht werden, um so Anreiz zu weiterer Verbesserung der Erzeugnisse zu schaffen. An erster Stelle müsste wohl jene Butter stehen, die das Prädikat "hochfein" erhält.

Die bei der Zentrifugierung der Vollmilch verbleibende Magermilch kann verschiedenartig verwertet werden. Mancherorts wird die Magermilch gerne von den Bäckern gekauft, sie wird aber auch zur Käseerzeugung, ferner Quark- und Caseinherstellung verwendet. Aus der Magermilch kann man auch Kondensmilch und Milchpulver herstellen und schliesslich wird auch aus der Magermilch beziehungsweise Molke, Milchzucker und Eiweiss gewonnen. Desweiteren halten viele Grossmolkereien eine eigene Schweinemast und -Zucht, sodass auf diese Weise, sei es Magermilch oder Molke Verwendung findet und gerade diese Art von Magermilch- und Molkenverwertung scheint mir die rentabelste zu sein.

Was beispielsweise den mir unterstellten Molkereigrossbetrieb anbetrifft so kann ich ganz offen gestehen, dass wir mit unserer seit mehr als drei Jahren aufgenommenen Schweinehaltung glänzende Erfolge aufzuweisen haben, wobei die Molkerei ihre Abfallprodukte und da hauptsächlich die Molke sehr gut verwertet. Wir stellen eben Ferkel ein, bringen dieselben auf ein Gewicht von rund 50 Kilogramme und stossen sie dann als sogenannte Futterschweine aus.

Nicht nur Magermilch, vielmehr auch Vollmilch wird zur Herstellung von Kondensmilch und Milchpulver herangezogen. Wir haben in dieser Beziehung zweierlei Arten von Betrieben. Die ersteren verlegen sich ausschliesslich auf die Herstellung von Kondensmilch und Milchpulver, während die letzteren als sogenannte kombinierte Betriebe dastehen und nur jene Milchmengen der Verarbeitung auf Dickmilch beziehungsweise Milchpulver zuführen, die sich als sogenannte Milchüberschüsse ergeben.

Ganz besonders im Kriege spielte Kondensmilch und Milchpulver eine bedeutende Rolle, da durch diese Art von Milchverwertung gewaltige Mengen wiederum als Milch dem Konsum zugeführt werden konnten.

Eine andere Art der Milchverwertung ist die Herstellung von sogenannten Präparaten, die aber gleichfalls als Hauptprodukt Milch

enthalten. Als ein solches Milchpräparat wäre vor allem die ganz besonders in den letzten Jahren stark forcierte Herstellung von Dauermilch zu bezeichnen. Auf jeder grösseren Milch- und landwirtschaftlichen Ausstellung finden wir derlei Erzeugnisse und geben uns diese Beweis dafür, dass die moderne Molkereitechnik auf dem richtigen Wege weiter vorwärtsschreitet.

Unter Dauermilch verstehen wir kurz gesagt, gewöhnliche homogenisierte Milch, die durch unmittelbare Erhitzung und Tiefkühlung haltbar gemacht wird. Die Homogenisation der Milch wird gleichzeitig mit der sogenannten Dauerpasteurisation in der modernen Molkereiwirtschaft über kurz oder lang vollen Einzug halten. Allerdings kommen auch noch heute die verhältnismässig hohen Anschaffungskosten in Betracht, wenngleich ich den Standpunkt vertrete, dass eine so behandelte Milch als Qualitätsmilch—Kurmilch oder Kindermilch—mit entsprechenden Preisaufschlag in Verkehr gebracht werden könnte.

Als vorzügliches Genussmittel dürfte dann noch Yogurt, Kefir und Taettemilch oder nordische Dickmilch als sogenannte Milchpräparate in Betracht kommen. Die Molkeriegrossbetriebe werden sich wohl jetzt wiederum genötigt sehen, geleitet vom Bestreben auf dem Gebiete der Milchhygiene und der modernen Milch- und Molkereiwirtschaft ihr Bestes zu bieten und deshalb auch zur Erzeugung vorerwähnter Milchpräparate schreiten.

Kefir ist ein schäumendes Milchgetränk, durch Zusatz von einer Bakterienart und Hefezellen, welche im Kaukasus ihre Heimat haben. In Verbindung mit Milch gebracht entsteht eine Gärung, wodurch der Milchzucker in Milchsäure einerseits und in Alkohol und Kohlensäure anderseits übergeht, auf diese Art gewinnen wir leicht ein mussierendes schäumendes Getränk von angenehm prickelnden Geschmack. Von den Aertzten wird dieses Milchgetränk besonders für Blutarme, ferner für Mast- und Kräftigungsbedürftige empfohlen.

Yogurt, auch bulgarische Sauermilch genannt, ist das Produkt einer reinen Milchsäuregärung durch Zusatz des *Bacillus bulgaricus*. Diese Milchsorte übertrifft die gewöhnliche Sauermilch an Wohlgeschmack. Die Balkanvölker, besonders die Bulgaren, die ein hohes Durchschnittsalter erreichen, sprechen dem Yogurt als bulgarisches Nationalengericht einen besonderen Heilwert zu. Es werden nämlich in Yogurt die Milchsäurebakterien isoliert, die gegen Fäulniserscheinungen im Darmkanal wirksam sind.

Taettemilch, auch Gesundheits Milch der Skandinavier, wird sich erst nach und nach eingebürgern müssen und wie mir bekannt, wird diese Milchgattung gleichfalls als ein hervorragendes Mast- und Kräftigungsmittel anempfohlen.

Mit Vorhergesagten glaube ich, zur Genüge die mannigfache Verwendungsmöglichkeit der Milch hier genügend beleuchtet zu haben, wenngleich ich damit durchaus nicht gesagt haben will, dass eine weitere Verwendungsart für Milch ausgeschlossen erscheint. Ich erwähne da nur kurz, dass man auch Milch, beziehungsweise Molke mit entsprechenden Zutaten Suppenwürze herstellen kann und so gibt es auch noch viele andere Verwertungsmöglichkeiten, auf die ich aber mit Rücksicht auf die beschränkte Zeit weiter nicht eingehen kann.

Wie von mir schon an erster Stelle gesagt, verstehen wir unter Kuhmilch—Vollmilch—das natürliche Produkt der Milchdrüsen der

weiblichen Säugetiere. Jede Entrahmung oder Verwässerung der Milch ist als Fälschung zu betrachten und von der Nahrungsmittelbehörde zu verfolgen und zu bestrafen. Wir wissen nur zu genau, dass Kuhmilch hauptsächlich den Milchbedürftigen zu Gute kommen soll. Es muss daher auch als ein Gebot der Notwendigkeit hingestellt werden, dass sowohl Milcherzeugung als auch Milchverwertung nach jener Richtung hygienisch und einwandfrei dasteht.

Wir alle haben eine gewisse moralische Verpflichtung für unsere Zukunft und das ist in erster Linie, für unsere Kinder zu sorgen. Für Kartoffeln, Fleisch, können immerhin Ersatzstoffe geboten werden; jedoch für Milch, soweit es sich hier um Milchnahrung für Säuglinge, stillender Mütter, und Kranke handelt, ist ein solcher nicht vorhanden.

Zusammenfassend glaube ich daher sagen zu können, dass Stadt und Land dafür zu sorgen hätten, damit das als unentbehrlich anerkannte Produkt in reichlicher Masse der Volksernährung zur Verfügung stünde, aber auch in einer solchen Weise, die dafür bürgt, dass die zum Verkauf gelangende Milch alle Anforderungen voll und ganz entspricht.

Wenn nun alle beteiligten Kreise auch tatsächlich gewillt sind, den Ausbau unserer Milchwirtschaft und des gesamten Molkereiwesens zu fördern und zu unterstützen, dann braucht um unsere Zukunft uns nicht bange zu sein, dann kommt eben auch wiederum die Landwirtschaft zur vollen Blüte und mit dieser innig verknüpft sehen wir das Wohl des Staates.

[Abstract.]

THE PRODUCTION AND UTILIZATION OF MILK.

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In this paper the author points out the absolute necessity for milk as an indispensable food of the human race and in proof he cites the suffering occasioned in central Europe by the curtailment of the milk supply during the World War. Inasmuch as milk is consumed largely in the raw state, every precautionary measure should be taken to insure its purity. Veterinary inspection and control of herds, Pasteurization, and the instruction of dairy helpers as to sanitary and hygienic methods of handling the milk, are a few of the important points discussed under the heading of production.

Under the subject of utilization, the author treats on the separation of milk, the uses of cream and skim milk, and lastly, the consumption of whole milk. For this latter use the author insists that there is no substitute, as in the case of meat and potatoes, and that for the welfare of the State an adequate supply of dairy products, and particularly consumers' milk, should be available at all times.

THE IMPORTANCE OF THE DEVELOPMENT OF THE DAIRY INDUSTRY IN INDIA.

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The dairy industry in India at the present moment is probably in a more backward and undeveloped state than in any other civilized country in the world. In the large cities of India to-day,

the price of pure milk is 100 per cent higher than it is in New York and Chicago, and in many parts of India it is impossible to procure reasonably pure and clean milk at any price. The great majority of Indian inhabitants do not eat animal food of any kind, excepting milk and milk products, and the health and physical well-being of the nation demands improved methods of milk production, handling, and sale. India imports large quantities of condensed milk, dried milk, milk sugar, and tinned milk foods of various sorts, all of which she should herself manufacture, but up to the present there is not even a single modern milk pasteurizing plant, on the retarding system, at work in this country.

The broad problem lying at the root of progress in India may be said to be the increase of the wealth-earning power of the masses, and the insuring of the benefits of this increased wealth to those who earn it, or, in other words, the increase in the wealth-producing capacity of the man in the field, and the prevention of the grabbing of this increase by parasitical classes, who do not help to earn it. India is mainly an agricultural country, and to advance its real prosperity not only must the wealth-earning capacity of the cultivator be increased, but the productive capacity of the soil must be enlarged and the agricultural resources of the country developed.

I know of no sphere of agricultural development which offers such a promising field in this direction as the development of the great dairying industry, because, as I hope to show later, the progress or otherwise of this industry very seriously affects the greatest of all agricultural problems in this country,—the cattle-breeding problem. The wisest of eastern monarchs has left it on record that "much increase is due to the strength of the ox," and this 3,000-year-old maxim may be taken as doubly applicable to India today. Every agricultural operation in this country, right up to and including the transport of produce to the rail, is dependent on the strength of the ox, and it follows that every addition we can make to the strength and efficiency of this animal is a direct increase to the wealth of the country; and if we can eliminate the money-lender there will be a corresponding advance in the standard of living of the man who owns and works the ox.

It is my opinion, based on 18 years' close contact with cattle breeding in all parts of the country, that the strength of the ox is decreasing in India, and that the country to-day does not breed the same quality of milk and draft stock it produced 12 to 14 years ago. This is due to a variety of causes, but principally, I believe, to the conserving of many of the old cattle-breeding jungles as forest reserves, and the spread of the canal irrigation system, thereby converting what were formerly cattle-breeding jungles into grain-producing areas. If this be so, and I think the fact is generally admitted by those who have studied the subject, then there is only one remedy, which every other country has had to adopt when it met a like problem, viz, the cattle must be bred on the cultivated lands. This can only be done, and will only be done, when it is economically sound for the cultivator to breed and rear cattle, and it is in order to make the breeding of cattle a payable proposition that the dairy industry must be developed.

I have heard it stated by those in authority in India that you can not produce a good class of draft bullock out of a first class milch cow. My experience does not confirm this; rather I maintain that you can not possibly produce the very best class of draft bullock out of anything but a really good milking cow. The ability to produce milk, Nature's all suitable food for the young, is the strongest and best proof of maternity, and the more efficient and perfect the dam, the more vigorous and healthy the offspring. The quality of yielding milk in no way clashes with draft points, and it can be proved that not only is there no antagonism between first-class draft qualities and the giving of milk, but they are identical, and in many parts of the world where oxen are used for tilling the soil the male offspring of the heavy milking breeds have been found satisfactory for this purpose. If, therefore, from the same dam we can produce the best draft cattle of any type required, from the heavy milkers of that particular type, it follows that the primary essential for successful cattle breeding in India is the development of the dairy industry. To make it economically advantageous for the cultivator or the grazier to breed and rear cattle, they must first obtain and breed from the profitable milk cow. Not only so, but given the good milker, the income of the breeder must be assured from both sides; i. e., the technical business part of the dairying industry must be developed so that the cow owner may manufacture and sell to advantage the milk or milk products from his cow, as well as the male progeny which will become the draft animals of the future.

It is in connection with the development of the technical and business side of dairying that the most successful results have been obtained in the application of cooperative methods to productive agriculture. In most countries of the world which have a peasantry who cultivate their own lands, the manufacturing and distributing side of the dairy industry is done on cooperative lines, and the result has been that not only do the small cow owners reap the whole of the benefits of their industry, but the educative and moral effect of cooperative association in this class of business has been of great value in teaching the small farmers business methods, the value of combination, and in time eliminating the usurer. I know of no reason why the same results should not follow the development of cooperative dairying in India, and if by means of cooperative dairying the Sowcar or Gombeen man of the East can be eliminated and the actual producer get the great part of the fruits of his labor, this is in itself a strong reason for the necessity of the advancement of the industry in India.

As things are now, in many cases the cow is useless for anything but dropping a male calf, and as it may be assumed that half of the animals born yearly will be males and half females, the greater part of the female stock born are an incubus on the land and, in breeding parlance, "eat their heads off." In short, as cattle breeding in India must in the future be done by the cultivator, it can not be made really profitable outside of the dual-purpose cow, producing milk in the case of the female and efficient draft qualities in the case of the male. No other system is practicable, as heifers not required for breeding can not be sold for beef in India, nor can they in many cases be

killed off as useless. In districts where male buffaloes are suitable for draft the same argument applies.

Every agricultural operation in India depends to some extent on the efficiency of the draft ox. This efficiency can only be increased and secured by the development and the fostering of breeding on dual-purpose lines; i. e., dairying and draft. From this point of view the development of dairying in India is of paramount importance, but there are other important reasons why the dairy industry in this country must be fostered, and of these I purpose to touch on two only, viz, (1) the necessity for a cheap and plentiful supply of dairy produce as a food of the people, and (2) the value of dairying as a means of maintaining the fertility of the soil where general farming is practiced.

(1) India is a vegetarian country, the people generally do not eat meat, and I do not think there is anything which can take the place of ghee and the various products made from milk, either evaporated or curdled, as wholesome, strengthening, and easily assimilated foods for the people, to say nothing of the absolute necessity for fresh milk for children and aged and infirm persons. The children of the nation are the hope of the future, and in these modern days, when the mother is so often unable to suckle her offspring, a cheap, pure, and plentiful milk supply will go a long way to reduce the heavy infant mortality in cities and large villages. At the present time in most large cities and many Indian villages, pure milk is a luxury of the rich, whereas it ought to be the common food of the poor. From the point of view of the health of the people at large and their food supply generally, the importance of the development of the dairying industry in India can not be overstated. There is no nation in the world whose people appreciate the product of the cow so much as the people of India, and yet to-day Indian cows generally are 100 per cent less efficient as milk producers than those of most civilized countries. That they can in time be made more efficient is a certainty, and it is a truism that the efficiency of the dairy cows of any country is a true indication of the general agricultural advancement of that country.

(2) The problem in front of the agriculturist in India, especially in the irrigated areas where failure of rainfall does not enforce frequent fallow years, is how to best restore the nitrogen, potash, and phosphates to the soil which the crops have removed, and there is no doubt that the development of dairying amongst the cultivators would, to a large extent, solve this problem. The land suffers in India from the want of what may be classed as mixed farming, and until the man who tills the soil gets into the habit of rearing and keeping cattle on his land, which can only be profitably done on dairying lines, there is no hope of his adequately manuring the land. If every cultivator fed a large part of the fodder grown on his land and a small part of the grain he produced to cattle housed on the land, the manure from the cattle, if carefully husbanded and scientifically applied, would greatly enhance the general richness of the soil and increase its productive capacity. It may be said here that the practice of burning manure so common in India would prevent this, but this factor also can only be altered on economic lines, and I believe that the introduction of general dairying would go a long way to

prove to the cultivator that the value of cow dung as a manure was in many cases greater than its fuel value, and in any case it would increase the quantity available so that an appreciable quantity would be left for manure after meeting fuel requirements.

To sum up, from an agricultural point of view the development of the dairy industry in India is of the greatest importance because:

(1) Only by this means can the greatest of all agricultural problems in India, the cattle-breeding problem, be placed on a sound economic basis.

(2) It particularly tends itself to development on cooperative lines; agricultural cooperation has been the business salvation of the small holder in many countries and it should be so in India.

(3) The solving of the cattle-breeding problem on dairying lines must at the same time enormously increase the productivity of the land, as the farmer will breed, rear, and feed his own animals on his own land, and their manure will be available to renew the fertility of the soil year by year.

From a general point of view, as apart from the purely agricultural aspect of the question, there remains the great and far-reaching effect of the development of this industry on the health of the common people. Cheap and pure dairy produce is essential to the health of the community; they can not get it now, and nothing but the development of dairying as a national industry will give it to them.

SESSION 22. CHEMISTRY AND BACTERIOLOGY OF MILK.

Honorary chairman, Dr. R. STENHOUSE WILLIAMS, research professor in dairy bacteriology, University College, Reading, England.

Chairman, Dr. R. W. THATCHER, director of experiment stations, Cornell University.

Secretary, H. E. DVORACHEK, head of the department of animal husbandry and dairying, University of Arkansas.

FIRST BAPTIST CHURCH ASSEMBLY HALL,
Syracuse, N. Y., Tuesday, October 9, 1923—9.30 a. m.

Chairman THATCHER. The meeting will come to order, please.

*I have the honor and the pleasure to introduce the honorary chairman for this morning's session, Dr. R. Stenhouse Williams, research professor in dairy bacteriology, University College, Reading, England. Dr. Stenhouse Williams. [Applause.]

We have a number of prepared papers for the program of this session, so I think we should proceed immediately to call the papers in the order in which they appear, with the understanding that if the author is not present when the paper is called for it will be moved to the end of the list and called for later in the morning.

The first paper is, "The classification of the lactic acid bacteria." May I introduce Dr. S. Orla-Jensen, professor of technical biochemistry, of the Royal Technical College, Copenhagen, Denmark. [Applause.]

THE CLASSIFICATION OF THE LACTIC ACID BACTERIA.

SIGURD ORLA-JENSEN, Ph. D., D. Sc., professor of technical biochemistry, Royal Technical College, Copenhagen, and president, Danish section of the International Dairy Association.

Since there exist many different organisms which are able to form at least small quantities of lactic acid, we must be very cautious in founding a family of lactic acid bacteria solely on the specially developed power of forming lactic acid. The bacteria which we call true lactic acid bacteria have, however, so many other properties in common that there can not be any doubt about their close relationship. Thus they, like the animals, make excessively great demands as to the nature of their nitrogenous nutriment and can grow only in the presence of proteins or complexes of amino acids, and most remarkably, in contradistinction to most other bacteria, they are unable to liberate oxygen from hydrogen peroxide. They have no nitrate reducing power, neither do they show surface growth in stab culture. They are gram positive, nonmotile, nonsporing rod

or sphere forms, usually dividing in one plane only. According to my researches¹ we can set up the following main groups:

(a) *Forming only traces of by-products in addition to lactic acid.*

Rod forms: Genus I. *Thermobacterium* (producing lævo or inactive lactic acid).
Rod forms: Genus II. *Streptobacterium* (producing dextro or inactive lactic acid).

Sphere forms: Genus III. *Streptococcus* (producing always dextro lactic acid).

(b) *Generally forming appreciable amounts of gas and other by-products in addition to lactic acid.*

Rod forms: Genus IV. *Bifidobacterium* (producing dextro lactic acid).

Rod forms: Genus V. *Betabacterium* (producing almost always inactive lactic acid).

Sphere forms: Genus VI. *Betacoccus* (producing generally lævo, seldom inactive acid.).

Before I now describe the different species, I should like to emphasize that I have only used constant properties for setting up these species, and, therefore, before beginning my classifying I studied all my strains over and over again for 10 years.

I have found that some of the properties mostly used for identifying the bacteria—i. e., their aspect in stab culture—often vary so strongly that they have very little systematic value. The ability to attack casein varies with the manner in which the bacterium is cultivated, and the ability to attack the different kinds of sugars varies with the nitrogen source. Also, the amount of by-products formed in addition to the lactic acid varies considerably. A strain of high vitality will, of course, utilize the source of energy to a greater extent and therefore produce more gas and volatile acid than a strain of lower vitality.

I have been very cautious in setting up new species, and therefore I am quite sure that I have not set up too many species. I rather think that my species will some time be divided further.

I. The members of the genus *Thermobacterium* are long rods, which do not thrive below 22° C. but grow very quickly at 40–50° C. or even at higher temperatures; hence, they generally gain predominance in milk kept above 40° C. They thrive well in yeast extract and, with the exception of *Tmb. cereale* (*Bacillus delbrücki*), which does not grow in milk, they attack casein to a considerable extent, and thus play an important part in the ripening of strongly scalded cheese, made in such a way that they will retain their heat for a long time. They thrive better without air and are, of all lactic acid bacteria, the strongest acid producers. The species forming lævo lactic acid may produce 1.7 per cent acid and the species forming inactive lactic acid may, in milk, produce even more than 2.7 per cent acid. They never ferment pentoses and frequently not salicin. To this genus belong the following species:

Tmb. helveticum (formerly called *Bacterium casei* ε), which plays the principal part in the ripening of Swiss (Emmental) cheese, forms inactive lactic acid and ferments maltose but not saccharose.

Tmb. jugurt, which occurs in Bulgarian sour milk (yoghurt). It forms feathery colonies on agar and produces inactive lactic acid.

¹ The lactic acid bacteria. Mémoires de l'académie royale des sciences et des lettres, de Danemark, section des sciences, sér. 8, v. 5, no. 2.

Tmb. bulgaricum, the most important yoghurt bacterium. It is rich in granules which stain more deeply with methylen blue than the rest of the protoplasm. It forms lævo lactic acid. Neither yoghurt rod-shaped bacterium ferments maltose or saccharose and they can be kept alive only in milk.

Tmb. lactis is the most common thermobacterium of milk. It forms lævo lactic acid and ferments both saccharose and maltose.

Tmb. cereale, the mash bacterium, used in the manufacture of spirits and yeast, forms lævo lactic acid and does not curdle milk.

II. Organisms belonging to the genus *Streptobacterium* can grow as long rods, but form, generally, long chains of short rods. The rods may be so short that, if rounded, they may resemble streptococci. They thrive best at 30° C. and seldom grow above 37° to 40° C. or below 10° C. They grow very slowly and need, even at the optimum temperature, at least two days to curdle the milk; but as they form and can stand much more acid than the streptococci they gradually predominate in dairy products, and are, therefore, always found in cheese.

I have established only two species:

Sbm. casei (*Bacterium casei* δ), which can break down the casein, is the most important cheese-ripening bacterium. It prefers lactose to saccharose and maltose and only exceptionally ferments raffinose, inulin and pentoses. It usually forms dextro lactic acid.

Sbm. plantarum, which can not break down casein, is usually found in souring vegetable matter, and accordingly ferments many different kinds of sugar. It usually forms inactive lactic acid.

III. The Streptococci usually grow out into long chains when cultivated in broth, but in milk and solid media they may present varied appearances. They are widespread and rich in species, and always produce only pure dextro lactic acid. The amount of this acid seldom exceeds 0.50 to 0.75 per cent; i. e., not much more than is required to coagulate milk. With the exception of *Sc. liquifaciens* the streptococci show very little tendency to hydrolyse casein, and completely lose the power to do so if not cultivated in milk.

From a dairy standpoint, the greatest interest attaches to *Sc. lactis* and *Sc. cremoris*. *Sc. lactis* (*Bact. lactis acidi* Leichmann), which always gains predominance in milk kept at ordinary room temperature, appears generally as diplococci in milk. It grows poorly, as a rule, below 10° C. and above 40° C. It ferments dextrin, but not saccharose. *Sc. cremoris* produces a good flavor in milk and, therefore, is used for ripening cream in buttermaking. If not weakened, it forms long chains in milk. It can grow between 3° to 35° C., but not at blood temperature. It does not ferment saccharose, maltose, or dextrin. Slime-producing strains are represented by the bacterium of ropy milk (*Bact. lactis longi* Troili-Petersson) and by the bacterium of ropy whey formerly used in the manufacture of Dutch (Edam) cheese (*Sc. hollandicus* Weigmann).

Of other Streptococci found in milk, mention should be made of *Sc. thermophilus*, which grows best at 40° C. and therefore is found in yoghurt and young Emmental cheese. It is irregular in shape and is easily isolated from milk which has been kept at a fairly high temperature. It ferments saccharose, but not maltose, dextrin, or salicin.

Sc. faecium is a typical diplococcus form, which grows even at 50° C., and is very common in the dung of mammals. It always ferments arabinose, as a rule saccharose, too, and frequently raffinose and rhamnose.

Sc. inulinaceus and *Sc. bovis* ferment inulin. The latter is the most common Streptococcus in cow dung, but is seldom found in milk, because it does not grow below 22° C.

Sc. glycerinaceus and *Sc. liquefaciens* are characterized by their power of fermenting glycerol and sorbitol. They grow well even at 45°. *Sc. liquefaciens*, the only gelatine liquefying streptococcus, peptonizes the milk and produces a bitter taste in butter and cheese; for that reason it was originally named *Micrococcus casei amari* by Freudenreich. It is always found in prematurely coagulating and cheesy milk. (By "cheesy milk" I mean milk that coagulates in the same way as if rennet had been added. The coagulum contracts, expelling the whey.)

Sc. mastitidis (*Sc. agalactiae*) is the cause of mastitis or inflammation of the udder in cows. It produces notable quantities of lactic acid in milk and resembles *Sc. cremoris*; but, unlike this, it ferments saccharose, maltose, and dextrin. It may be recognized by the orange-colored matter which it produces after some time in agar or broth containing casein, peptone, and soluble starch. According to my researches, human mastitis is caused by the same Streptococcus as the bovine mastitis.

Sc. pyogenes is a general term for a number of pathogenic streptococci which do not coagulate milk.

IV. Bifidobacterium is the generic name which I have given to the club-shaped or forked anaerobic lactic acid bacteria (*Bacillus bifidus* Tissier) that constitute the overwhelming majority of the bacteria present in the feces of infants. They produce considerable quantities of acetic acid in addition to dextro lactic acid. They recall the Betabacteria in their relation to the sugars. Some species do not ferment saccharose, but all ferment lactose and maltose which, therefore, may be considered as better sugars for bottle-fed infants than saccharose.

V. The Betabacteria, in the freshly isolated state, produce perceptible amounts of gas, succinic acid and other by-products. They do not ferment salicin, and mannose only with difficulty. They have no action at all on casein, but thrive best in yeast extract. As examples, may be mentioned the cheese bacteria *Bbm. breve* and *Bbm. longum* (*Bacterium casei* γ and δ , respectively). The former ferments arabinose strongly and frequently also xylose; it has a maximum temperature of 38° C. The latter never ferments arabinose, but frequently ferments xylose and raffinose; its maximum temperature is 45° C. *Bbm. caucasicum* is the chief constituent of kefir grains; it forms, even at ordinary room temperature, appreciable amounts of acid when with yeast, but does not thrive in milk without yeast.

VI. The Betacocci have been so named by me because they are generally found in beets, mangold wurzels, and swedes. As strong pentose fermenters, they contribute to the breaking down of the

pectins. In countries where such roots are largely used as cattle feed, the Betacocci are of very common occurrence in milk and in the cheese made therefrom. Some Betacocci can divide in two directions, but they occur usually as diplococci or short chains, which can not be distinguished from the streptococci. But in contradistinction to these, they usually form lævo lactic acid and render saccharose broth more or less slimy. The slimy fermentation may best be observed in stab culture in saccharose gelatine. The leuconostoc, which may give a great deal of trouble in beet sugar manufacture, are such slime-producing Betacocci. The sour cabbage bacterium (*Sc. brassicae*) also belongs to this genus. I have set up only two species: *Bc. arabinococcus*, which ferments arabinose and xylose very strongly and *Bc. bovis*, which never ferments arabinose and frequently not xylose.

More or less related to the true lactic acid bacteria are the pseudo lactic acid bacteria, which may be divided in two groups:

(a) Bacteria which are gram positive and usually make as great demands as to the source of nitrogen as do the true lactic acid bacteria, but which usually form catalase, reduce nitrates, and show surface growth.

I. The Microbacteria are small rods, which stand fairly high temperatures and, therefore, may be found in Pasteurized milk. To the genus Microbacterium belongs the feces bacterium which was formerly very inaptly named *Bacillus acidophilus*.

II. The Tetracocci include the acid-producing forms of micrococci and sarcinae.

(b) Bacteria which are gram negative and are content with ammonium salts as a source of nitrogen.

The coli-aerogenes bacteria.

Chairman THATCHER. Each paper as it is presented is open for discussion. May I suggest that this paper and the two following are closely related and that discussion of the general phases of these topics might well be deferred until the close of Doctor Rettger's paper? But if there are, at this time, particular questions on matters presented by Doctor Orla-Jensen, the opportunity to ask them is given. Is there discussion on this paper?

Honorary Chairman STENHOUSE WILLIAMS. I don't think the paper should be passed without recognition of the enormous service Dr. Orla-Jensen is giving to-day by classifying the most difficult type of organisms that exists. It is a service which none of us has appreciated as yet, but it is one of the biggest ones done for our work. [Applause.]

Chairman THATCHER. Is there further discussion on the paper? If not, we will call for the paper on "The important streptococci of milk and the relation of bovine hemolytic types to those of human origin," by Mr. S. H. Ayers, research director, Glass Containers Association, formerly of the United States Department of Agriculture. Mr. Ayers.

THE IMPORTANT STREPTOCOCCI OF MILK AND THE RELATION OF BOVINE HEMOLYTIC TYPES TO THOSE OF HUMAN ORIGIN.

S. HENRY AYERS, research laboratories, Dairy Division, United States Department of Agriculture.

IMPORTANCE OF STREPTOCOCCI IN MILK.

The streptococci of milk offer an interesting and important field for study, because among them are found harmless and even useful organisms, as well as extremely virulent ones at occasional times.

The confusion as to the streptococci in milk has led to various interpretations as to their significance in it and in other dairy products. Their presence has been considered by some authorities to be an indication of fecal contamination from the cow, and by others to be an indication of inflammation of the udder. In such cases the presence of the streptococci was considered the significant thing, and no attention was given as to what kind they might be. It was felt that further studies of the streptococci, using all the most valuable physiological tests for their differentiation, would prove valuable. For this reason the studies reported here were undertaken.

The methods of isolating cultures and cultural methods are fully described in other papers by the author and his associates (2), (3), (4), (5).

CULTURAL CHARACTERISTICS OF THE STREPTOCOCCI OF THE UDDER.

Most of the udder cultures in our collection came from apparently normal cows. A few, however, were from cows having mastitis. These cultures were not separated from the others, because we have not found any particular organism to be characteristic of inflamed udders. The types found in the normal udders were the same as in the cows with mastitis, the only difference being in the larger numbers found in the cases where mastitis was present. The 100 cultures studied were obtained from 55 samples of milk taken from 54 cows in two herds near Washington. One cow was examined twice.

It will be observed from Table 1 that 79 of the 100 cultures were varieties of *Streptococcus mastitidis*. Of these, 64 gave the beta type of hemolysis. In other words, these cultures were hemolytic on blood plates. The terms, beta, alpha, and gamma types of hemolysis are those applied and described by Smith and Brown (24), and more fully described by Brown (6). The streptococci listed in the table represent the "majority streptococcus flora" from each source studied. The difference between the total number of cultures studied and the number of cultures of the species listed consisted of miscellaneous species.

The 79 cultures were all long-chain-forming streptococci. Particular attention is called to the fact that they all hydrolyzed sodium hippurate, forming benzoic acid and glycol.

Because of our nonselective method of isolation, we feel that these streptococci represent the "majority streptococcus flora" of the cow's udder. They may be grouped and called *Streptococcus mastitidis*

Guillebeau. There are apparently two varieties, hemolytic and nonhemolytic, which may be termed beta and gamma varieties.

Nocard and Mollereau (20) in 1887 isolated a long-chain-forming streptococcus from a case of contagious mastitis; and from the rather meager description it would appear to be the common udder type encountered in our studies. It is interesting to observe that Nocard and Mollereau found that they could reproduce the disease by inoculation. The organism appears to have been termed *Streptococcus mastitidis contagiosae* by Guillebeau (12). Orla-Jensen (14) has also applied the name *Streptococcus mastitidis* to the organism causing mastitis.

STREPTOCOCCUS MASTITIDIS.

Streptococcus mastitidis is characterized as follows: Does not reduce methylen blue; coagulates litmus milk usually in 24 hours, and partially decolorizes the milk after coagulation; does not grow in milk at 10° C. Ferments dextrose, lactose, and cane, and may or may not ferment salicin. Does not ferment mannite, raffinose or inulin. Produces CO₂ and NH₃ from peptone, but no CO₂ from dextrose. Hydrolyzes sodium hippurate into benzoic acid and glyocol. There are two varieties; one which produces the beta type of reaction, and the other which produces the gamma type of reaction on blood agar plates.

Streptococcus mastitidis seems to agree in the ordinary cultural characteristics with *Streptococcus pyogenes* found to be common in the udder by Rogers and Dahlberg (21). Sherman and Albus (22) also found the *Streptococcus pyogenes* type, fermenting dextrose, lactose, saccharose, and sometimes salicin, to be the characteristic streptococcus of the udder; and they pointed out the value of the negative reduction of methylen blue and the inability of this type to grow at 10° C. Jones (15), (16), in a study of streptococci from the udder of cows having mastitis, found they could be separated into two groups, one fermenting dextrose, lactose, maltose, and saccharose, and the other salicin in addition. Both his hemolytic and nonhemolytic cultures fell into these two groups.

Twelve of the remaining cultures, the characteristics of which are omitted from the table, represent what appears to be a new species of streptococcus, which has been named merely as a matter of record. They generally showed the alpha type of hemolysis, which in most cases was very distinct. No change was observed in litmus milk, and they produced but little acid in fermentation tests. This is the most characteristic feature of these organisms.

In the yeast-peptone medium the pH decreased from 7.5 to about 6.2. This medium was lightly buffered and for this reason the weak fermentations were observed. There was considerable variation in the test substances fermented. These organisms also formed CO₂ from infusion-peptone broth; but no NH₃. The CO₂ seemed to come from organic acid salts. Because of their ability to produce only a little acid from test substances, we have termed these cultures varieties of *Streptococcus acidominimus*. These organisms apparently are different from those observed by Holman (13) and called *Streptococcus ignavus* on account of their lack of fermentative ability.

FREQUENCY OF THE PRESENCE OF STREPTOCOCCI IN THE UDDERS OF COWS.

Streptococci occur very frequently in the udders of normal cows. This has been shown by Sherman and Hastings, (23), Evans, (8), Jones, (17), and Frost and Bachmann (10). In our studies, streptococci have been isolated by direct platings of milk from the udder of 51 of the 133 normal cows examined. This represents about 33 per cent of the animals tested. They were isolated from each of 17 cows having mastitis, and varied in three cases, from a few thousand to many millions. In some animals with mastitis the predominating streptococcus was the hemolytic (beta) variety and in other cases the nonhemolytic (gamma).

It seems evident that *Streptococcus mastitidis* is commonly found in the udders of normal cows, and also, to a less extent, other species of streptococcus. The fact that milk containing these organisms has been consumed regularly with no ill effects, indicates that these streptococci need not be feared. In this connection the experiments of Nocard and Mollereau (20) are of interest. They isolated a streptococcus, apparently *Streptococcus mastitidis*, and fed cultures to dogs and rabbits. No ill effects were noted, and they concluded that milk, containing these organisms, could be used for food without danger. Jones (15) also fed nonhemolytic udder streptococci to a pig with no bad results.

THE STREPTOCOCCI OF COW FECES.

The streptococci of cow feces have been found by Winslow and Palmer (25), Fuller and Armstrong (11), Rogers and Dahlberg (21), and Jones (18) to be characterized by their ability to ferment raffinose. In this respect they differ from the human fecal type. The predominating cow fecal streptococcus is usually considered to be of the *Streptococcus salivarius* type of Andrews and Horder (1). The latter authors found this type to be the most common in saliva.

Our fecal cultures consisted of organisms isolated from 30 samples of cow feces from about 30 cows.

Our results confirm those of former investigators, as will be seen from Table 1. Of the 78 cultures, 75 were found to be of the typical cow fecal type. These cultures showed only short chains averaging 6 to 10 cells in broth. On blood plates, the colonies had a very slight hemolytic zone, as a rule. They might be called weak beta types, although some investigators might call them gamma types. It will be noted from the table that 54 of the cultures fermented raffinose and 21 inulin in addition.

The interesting features of the "majority cow fecal streptococcus" is the fact that no CO_2 or NH_3 was produced from pepton, no CO_2 from dextrose, and that sodium hippurate was not hydrolyzed.

It is believed that these cultures represent the *Streptococcus bovis* type described by Orla-Jensen (14). There seem to be two varieties, one which ferments inulin, and one which does not. The typical raffinose-fermenting cow fecal type appears to be somewhat different from the raffinose fermenting salivarius type of human saliva.

TABLE 1.—Characteristics of streptococci from different sources.

Source and total number of cultures.	Number of cultures.	Hemolysis.	pH in fermentations.						CO ₂ from—		NH ₃ from peptone.	Sodium hippuric hydrolyzed.
			Dextrose.	Lactose.	Saccharose.	Salicin.	Mannite.	Raffinose.	Inulin.	Peptone.		
Udder 100.....	{ 64	Beta.....	4.5+	4.5+	4.5+	{ 7.3— or 4.5+ 7.2— or 4.5+ 4.5+ }	7.3—	7.3—	7.3—	+	+	+
		Gamma; some green.....	4.5+	4.5+	4.5+	{ 7.2— or 4.5+ 4.5+ }	7.2—	7.2—	7.2—	+	+	+
		Usually show slight hemolytic zone about colony not clear of blood corpuscles. do.....	4.5+	4.5+	4.5+	4.5+	7.5—	4.5+	7.5—	—	—	—
Feces of cow, 78.....	{ 21	do.....	4.5+	4.5+	4.5+	4.5+	7.5—	4.5+	4.5+	—	—	—
		Usually show slight hemolytic zone about colony not clear of blood corpuscles. Beta.....	4.6+	4.6+	4.6+	4.6+	7.0—	4.6+	4.6+	—	—	—
Mouth of cow, 80.....	69	do.....	5.4+	5.4+	5.4+	5.5+	7.4—	7.4—	7.4—	+	+	+
Human, mostly pathologic conditions, 32.	{ 23	do.....	5.4+	5.4+	5.4+	5.5+	5.5+	7.4—	7.4—	+	+	+
		do.....	5.4+	5.4+	5.4+	5.5+	5.5+	7.4—	7.4—	+	+	+

Streptococcus mastitidis var. beta.
Streptococcus mastitidis var. gamma.
Streptococcus bovis var. A.
Streptococcus bovis var. B.
Streptococcus bovis var. B.
Streptococcus pyogenes.
Streptococcus infrequens.

Two of the remaining fecal cultures, not listed in Table 1, were of interest, because of characteristics which place them among the organisms of the *Streptococcus acidominimus* type, which were found in the udder and described earlier in this paper. It is possible that the udder becomes occasionally infected with this type of streptococcus.

THE STREPTOCOCCI OF THE MOUTH OF COWS.

The streptococci of the mouth of cows have been found to be of the *Streptococcus bovis* type of cow feces. It must, however, be pointed out that these cultures were isolated from the back of the mouth, toward the base of the tongue, and considerable care was taken in making swabs.

The results of the study of 80 cultures, isolated from the mouths of 26 cows, are shown in Table 1. It will be noted that 69 of the cultures were of the inulin-fermenting variety B of *Streptococcus bovis*, the typical cow fecal type.

Only 10 out of 80 cultures fermented mannite, which is quite different from the results obtained by Rogers and Dahlberg (21), who found that 87.2 per cent of these cultures from the mouth of the cow fermented this alcohol. They also found that about 82 per cent of their cow-mouth cultures reduced litmus, which is quite different from our results. Perhaps their cultures came from the front of the cow's mouth, and the flora there may be different from the back of the mouth, where our cultures were isolated.

It was interesting to find that the characteristic streptococcus of the back of the mouth of the cow was the same as var. B of *Streptococcus bovis*, the typical streptococcus of cow feces.

STREPTOCOCCI OF MARKET MILK.

Thus far we have considered the most important streptococci from definite sources from which most of the streptococcal contamination is likely to come. There are, of course, other sources, such as milk utensils, contamination from the air, and human sources. The number of streptococci introduced from these sources is likely to be small. Contamination from utensils is an exception to this statement, because large numbers may be introduced from this source.

The relation of the species of streptococci likely to be introduced into milk in the largest numbers to those found in market milk will be of interest.

Jones (18) studied the streptococci of low count market milk, which averaged about 3,000 bacteria per cubic centimeter, and found that the majority agreed in cultural reaction with udder types. This might be expected, since from the low counts of the milk, it was evidently produced under clean conditions in sterilized utensils, in such a manner that practically the only source of contamination came from the udder.

We have been particularly interested in the growth of streptococci in milk, and for that reason made a study of these organisms found in souring milk.

Samples of milk, produced under ordinary farm conditions, were allowed to stand at a warm temperature, until a slight change in acidity was noted, and then examined. Cultures were isolated from 40 samples of raw milk, having an acidity of from 0.18 to 0.25 per cent, from 8 samples of milk, having an acidity of 0.30 to 0.49 per cent, and from 29 samples, with an acidity of 0.60 per cent or more. The results of this work are shown in Table 2, which gives the percentage of different streptococci found.

TABLE 2.—Per cent of different streptococci found in souring milk.

	Per cent acidity as lactic acid.		
	0.18-0.25	0.30-0.49	0.60+
<i>Streptococcus lactis</i>	27.7	59.0	92.3
<i>Streptococcus kefir</i>	67.4	41.0	6.7
Miscellaneous streptococci.....	4.9	0	0

In milk, held at a warm temperature until acidity had increased slightly up to 0.18 to 0.25 per cent acid, the predominating streptococcus, to the extent of 67.4 per cent of the cultures, was of the kefir type. There were about 5 per cent of miscellaneous streptococci, and 27.7 per cent of the lactic type.

As the acidity increased the per cent of the lactic type increased until the streptococci in milk, with an acidity of 0.6 per cent or over, consisted of 92.3 per cent lactic type, and 6.7 per cent of *Streptococcus kefir*.

It is interesting to observe that no streptococci belonging to groups common to the udder, cow feces, or the cow mouth, were found in souring milk. Such organisms might, of course, have been present, but in such small numbers that they could not be detected without special methods.

The streptococcus flora of souring milk seems to consist largely of the kefir and lactis types. The kefir type predominates in milk of low acidity, and the lactis type in milk of higher acidities. *Streptococcus kefir*, which is the name given by Migula (19) to the gas-forming streptococcus found by Freudenreich (9), produces gas from dextrose, but, by ordinary cultural tests, may easily be mistaken for the cow fecal type, which, however, does not produce gas.

DIFFERENTIATION OF HEMOLYTIC STREPTOCOCCI OF BOVINE AND HUMAN ORIGIN.

Hemolytic streptococci in milk have been looked upon with suspicion because of their apparent close relationship to pathogenic human hemolytic types. We believe, however, that they are not the same species, or at least not the same variety of the species.

If the cultural characteristics of *Streptococcus mastitidis*, var. beta, the bovine hemolytic streptococcus, is compared with the culture shown in Table 1, certain striking differences, such as the difference in final pH (under controlled conditions), and the difference in ability to hydrolyze sodium hippurate, will be at once evident. In a dextrose yeast medium, the bovine hemolytic streptococcus carries

the pH to about 4.5, while the human type reaches only about pH 5.5. The bovine type hydrolyzes sodium hippurate while the human type does not. The human type is about 100 times more hemolytic than the bovine type when hemolysis is measured in tubes.

For the sake of clearness, we have listed below the characteristics of what we consider *Streptococcus mastitidis* (bovine hemolytic species) and also *Streptococcus pyogenes* (human hemolytic species).

	<i>Streptococcus mastitidis</i> (var. beta; var. gamma).	<i>Streptococcus pyogenes</i> .
Blood agar plate.....	Beta type ¹ (weak); gamma type.	Beta type ¹ (strong).
Dextrose.....	pH about 4.5 in dextrose-yeast broth. ²	pH about 5.5 in dextrose-yeast broth. ²
Lactose.....	+	+
Saccharose.....	+	+
Salicin.....	±	±
Mannite.....	—	—
Raffinose.....	—	—
Inulin.....	—	—
CO ₂ from pepton.....	+	+
CO ₂ from dextrose.....	—	—
Hydrolysis of sodium hippurate.....	+ ²	— ²
Milk at 37° C.....	Coagulated, partly decolorized after coagulation.	Acid, may be coagulated.
Milk at 10° C.....	No growth.	No growth.
Methylen blue milk.....	No decolorization.	No decolorization.

¹ Although both bovine and human types show the beta type of hemolysis on blood plates, the human type is about 100 times more hemolytic than the bovine type, as shown by hemolysis in tubes. This point has also been shown by Brown (7).

² Note particularly these reactions.

For a further discussion of this subject reference is made to other papers (3), (4).

SUMMARY AND CONCLUSIONS.

1. The streptococci from some of the important sources of contamination of milk have been studied and traced through the souring period of milk. The cultural characteristics of the typical streptococci of the udder, feces, and back mouth of cows are described. Studies of the kefir and lactic types of streptococci are not sufficiently complete to be included.

2. The typical streptococcus of the udder of the cow was found to be *Streptococcus mastitidis*. There is a hemolytic and nonhemolytic variety.

3. An apparently new species was found in the udder which, because of the small amount of acid formed in test substances, is termed *Streptococcus acidominimus*.

4. It is shown that streptococci are very frequently found in the udders of normal cows, and that the same species are also present in cases of mastitis. There appears to be no reason to believe that *Streptococcus mastitidis* is pathogenic for man when consumed.

5. The typical streptococcus of cow feces was found to be *Streptococcus bovis*. There appear to be two varieties.

6. The typical streptococcus of the back of the mouth of cows is the same as *Streptococcus bovis* var. B.

7. By ordinary cultural tests *Streptococcus kefir* may be mistaken for *Streptococcus bovis*. It may be easily identified by the formation of gas from dextrose, but special methods must be used to detect gas formation. *Streptococcus bovis* does not form gas.

8. Streptococci from the sources described probably always contaminate milk, but have not been found in souring milk. It appears that they are easily overgrown. As milk sours, *Streptococcus kefir* predominates in the ordinary grade of milk with low acidity, and the *Streptococcus lactis* in milk of high acidity. Neither *Streptococcus kefir* nor *Streptococcus lactis* has been found in the udder, feces or back mouth of the cow.

9. *Streptococcus mastitidis*, the bovine hemolytic streptococcus, can be readily differentiated from the human hemolytic streptococcus.

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Chairman THATCHER. Is there discussion of the paper by Mr. Ayers?

Dr. S. ORLA-JENSEN. I should like to ask Mr. Ayers what kind of lactic acid does *Streptococcus kefir* produce?

Mr. S. H. AYERS. We have not worked on types.

Dr. S. ORLA-JENSEN. I think it would produce lactic acid.

Mr. S. H. AYERS. Very likely. We haven't worked on that particular point.

Chairman THATCHER. Is there other discussion? If not, we will pass to the third paper of this group, "Lactic acid bacteria with special reference to the *Bacillus acidophilus* type," by Dr. L. F. Rettger, professor of bacteriology at Yale University. [Applause.]

LACTIC ACID BACTERIA WITH SPECIAL REFERENCE TO THE BACILLUS ACIDOPHILUS TYPE.

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I want to preface this paper with the statement that I expected to speak to a mixed audience of bacteriologists and dairymen so it was hard for me to know just how to meet the requirements. My paper is semiscientific rather than purely scientific, and I hope you will look at it in that way.

The group of so-called lactic acid bacteria is one whose importance is impressed upon us more and more. It is not to be confused with the butyric acid organisms; the two are readily distinguished on account of their biochemical reactions. Lactic acid bacteria are characterized by their property of attacking carbohydrates with the formation of lactic acid as a featuring product, whereas the acids formed by the butyric acid group are, as the word implies, largely butyric acid, which is responsible for the characteristic odor of the cultures. Well-known examples of the butyric acid type of organism are *Bacillus butyricus* (*Clostridium butyricum* Prazmowski) and *Bacillus aerogenes capsulatus* Welch or *Clostridium welchii*. The present paper will deal with the lactic acid forms.

Three well-known general types of the lactic acid bacteria are: (1) The *Bacterium coli* and *Bacterium aerogenes* type of Escherich; (2) *Streptococcus lacticus*, and (3) *Lactobacillus caucasicus* Beijerinck (*Bacterium caucasicum* Kern).

These three types differ from each other very materially in morphology and cultural reactions, and, although they are all lactic acid

producers, they occupy widely separate positions in classification schemes. The coli-aerogenes type is very unlike the other two in that it grows readily and luxuriantly in the ordinary culture media and produces a very wide range of products, particularly nitrogenous, besides lactic and closely related acids. This type is often referred to also as a putrefactive type because of the more or less disagreeable products which it elaborates, although the more recent researches have shown clearly that it does not attack native proteins. While it occurs generally in market milk, it can not be regarded as an economically important lactic acid type. In fact, its rôle in dairying and allied industries is to be looked upon generally as a harmful one.

Streptococcus lacticus Kruse (*Bacterium lactis-acidi* Leichmann, *Micrococcus lacticus* Migula) is a strictly lactic acid type. It is regularly present in cow's milk and is responsible largely for the natural souring of the milk. This organism is now generally accepted as a coccus form which, although it usually exists in short chains, may at times resemble more or less a real streptococcus. *Streptococcus lacticus* has for a number of years been employed as a starter for the ripening of cream for butter making and the flavoring of cheese and other dairy products. At optimum temperatures it develops rapidly in milk, bringing about complete coagulation of the casein and developing a maximum acidity of about 1 per cent in terms of lactic acid. Its importance in the dairy industry has been quite generally recognized.

It is the third group of the so-called lactic acid bacteria to which the main interest in this paper attaches, namely the *Lactobacillus caucasicus* group with its economically important types. The group is by many still referred to as the caucasicus or caucasicum group because this name was conferred on representatives of this group before Massol, Moro, and Tissier discovered and named their respective organisms. There are now known to be three distinct, yet closely allied, types in the caucasicus group, namely, *Lactobacillus bulgaricus*, or the bacillus of Massol, *Lactobacillus acidophilus* Moro and *Lactobacillus bifidus* Tissier.

The first of these types was isolated in Massol's laboratory at the behest of Metchnikoff, and shown by him and others to be the chief organism responsible for the souring of milk in the oriental sour milk products, particularly the Bulgarian.

The bacillus of Massol or *Lactobacillus bulgaricus* has attained wide use in the production of sour milk as a beverage and therapeutic product. Metchnikoff believed that the vigor and long life of the Bulgarians and other Balkan nations were due to the almost constant use of sour milk, prepared in certain ways according to the respective customs, and that the beneficial action of the sour milks was to be ascribed to one organism in particular, *Bacillus* (*Lactobacillus*) *bulgaricus*. There are relatively very few biological laboratories which have not prepared bulgaricus milk, tablets, powders, etc., and marketed them as so-called therapeutic agents.

According to Metchnikoff, *Bacillus bulgaricus*, when taken by mouth, establishes itself in the intestine, and as a consequence replaces the so-called harmful types of bacteria, that is, the organisms causing intestinal putrefaction. Being itself a harmless and non-

putrefactive type, it thus confers a benefit upon the host by preventing the formation of toxic or poisonous products, which under ordinary conditions of diet, are formed, and which, by their cumulative action, work injury to the host. These claims will receive further comment.

Bacillus acidophilus and *Bacillus bifidus* are the remaining two types which are in the caucasicus group. These two organisms resemble each other and *Bacillus bulgaricus* in several very important respects; in fact it is, at times, difficult to determine the lines of division by the ordinary laboratory tests. All three of these organisms are strongly gram-positive in young culture, and occur as distinctly rod-shaped, or as long or short filaments, frequently more or less wavy. While each type is known to occur in branched form, the *Bacillus bifidus* in particular is bifurcated and may be seen as a Y or a T form in almost any and all cultures, whereas branching of the other two types is relatively rare.

All three types are more or less pleomorphic, that is, their morphology varies considerably within a rather wide range. All three of the above types require carbohydrate or some other special carbon-furnishing agent for development. The growths on ordinary culture media are more or less delicate. *Bacillus bulgaricus* and *Bacillus acidophilus* produce the characteristic fuzzy or hairlike colonies which consist usually of a very small central body with numerous long and short wavy threads radiating from it.

Bacillus acidophilus and *Bacillus bifidus* are intestinal forms, whereas *Bacillus bulgaricus* is strictly non-parasitic, and occurs in certain sour milks, especially those of the Balkan and oriental countries; also in ordinary silage, sauerkraut, and similar food products which undergo marked acid fermentation.

Recent experiments in this laboratory have clearly shown that *Bacillus bulgaricus* can not be implanted, and can not be made to thrive, in the intestine of man or of the white rat. On the other hand, *Bacillus acidophilus* may, without difficulty, be established in the intestine, and encouraged to undergo rapid proliferation by the use of appropriate diet. *Bacillus bifidus* responds in a more or less similar way, but its requirements as to diet are distinctly more exacting.

BACILLUS ACIDOPHILUS.

This organism has received very much attention within the last five years. It was discovered by Moro and described by him in 1900 (Jahrbuch f. Kinderheilkunde, vol. 52, pp. 38-55) and is frequently referred to as the Moro bacillus. This organism was found by him in the feces of very young, and particularly breast-fed infants. In babies receiving mother's milk as the only food, the organism was found by him to be present as the greatly predominating type, and he believed this to be the characteristic type in such infants.

In the same year Tissier announced the discovery of his so-called *Bacillus bifidus* (Recherches sur la flore intestinale normale et pathologique du nourrisson. Thèse, Paris, pp. 85-96), and claimed this as the predominating organism of early infancy, that is, during the period of breast feeding. As this organism and the Moro

bacillus are in several respects so much alike, it is not surprising that some controversy should have arisen as to the correctness of each of the claims. There is no doubt that both of these authors were in a large measure correct, for it is now well known that *Bacillus acidophilus* and *Bacillus bifidus* may and do occur at the same time, and interchangeably, in the intestine of nursing children, as well as in most of the ordinary mammals. In experimental work with the two organisms, it is much more difficult, however, to implant *Bacillus bifidus* than *Bacillus acidophilus*. For this reason largely most attention has been given in this laboratory to the Moro organism.

According to Escherich, Moro, and Tissier, the intestinal contents of the new-born infant are sterile. Soon after birth adventitious organisms make their entrance, particularly through the mouth and at the first feeding. These are not established types, but are soon followed by established types, the nature and number of which are determined by the food supplied. After a short time following the first breast feeding, *Bacillus acidophilus* and *Bacillus bifidus* appear in large numbers in the intestine, and remain the predominating types as long as the diet is continued. On the introduction of cow's milk into the daily diet, both of these organisms lose their prominence to a certain extent. When the diet is gradually changed from milk alone to milk plus egg, bread, cereal, etc., the intestinal flora assumes more and more the character of that of the adult, until, finally, when the usual mixed diet prevails, the Moro and the Tissier bacilli have, as a rule, almost completely disappeared from the intestine and may be recovered from the feces with some difficulty.

Recent experiments on the human subject and on the white rat have clearly shown that *Bacillus acidophilus* can be encouraged to develop in large numbers in the intestine of adults as well as in the young. Such development can be brought about readily by the administration of lactose (sugar of milk) and of dextrin. Hull and Rettger (Journal of Bacteriology, 1917, vol. 2, pp. 47-71) showed that when grown rats are fed 2 grams of lactose daily there is a pronounced change in the character of the intestinal flora, from the usual mixed types, to one that is greatly simplified, and often exists to almost the entire exclusion of all other forms, namely, *Bacillus acidophilus*. The change in flora may be observed easily by examination of stained microscopic slides, by agar plate colony study, and by the gas-production test in deep sugar agar. The microscopic slide, when the transformation is practically complete, shows gram-stained rods, and in general the picture of a pure or almost pure mount of *Bacillus acidophilus*. Gas-producing organisms have been reduced and may be entirely absent, and the agar plates show characteristic acidophilus colonies, with at the most but few other types of colonies present.

When the amount of lactose or dextrin fed daily is increased from 2 grams to 3 grams, there is a further change in the intestinal flora, and *Bacillus bifidus* often becomes the predominating type. The change is easily seen in the stained films by the appearance of a gram-stained type which is more irregular than the acidophilus

in its morphology, and which shows many branched (Y and T) forms; also in the deep agar tubes by the character of bifidus colonies. This is *Bacillus bifidus* which has at least in a large measure displaced the Moro bacillus, due to supplying its lactose and dextrin requirements which are decidedly more exacting than those of *Bacillus acidophilus*.

Similar results were obtained by Rettger and Cheplin in man. However, it was more difficult to bring about as complete or nearly complete changes in the human subject as in the rat. For bringing about very marked transformation in intestinal types of bacteria, from 250 to 300 grams of lactose were usually required daily for adults. In one instance as much as 400 grams was necessary. On the other hand, a number of the subjects were extremely susceptible to very small amounts of lactose and to ordinary sweet milk. In a few cases, 25 to 50 grams of milk sugar were sufficient to bring about a very marked transformation of the intestinal flora. Milk alone to some extent may favorably influence the aciduric types of organism in the intestine. The stimulating action of the milk is, without doubt, due to the lactose present.

Feeding experiments with broth or whey, or with milk cultures of *Bacillus acidophilus* have given results quite similar to those obtained with lactose and dextrin. When 3 cubic centimeters of young whey culture were given to rats daily, the complex intestinal flora underwent simplification to the acidophilus type. The transformation was at times practically complete, and as a rule amounted to at least 90 per cent.

Similarly, when human subjects took 300 cubic centimeters of whey culture daily, there was a change in the character of the flora which began to make itself manifest within three to four days, and which frequently resulted in the establishment of *Bacillus acidophilus* to the extent of at least 85 to 90 per cent of the organisms present.

When the above amounts of broth culture were cut in half, that is, when 1.5 cubic centimeters of broth was given to the rats and 150 cubic centimeters to the human subjects daily the transformation of intestinal types was only partial, seldom amounting to more than half of that obtained when the full amounts of broth were given. On the addition of 1.5 grams of lactose to the 1.5 grams of whey culture and of 150 grams of lactose to the 150 cubic centimeters of whey culture, there was again a very pronounced increase in the aciduric type which at times attained at least 85 to 90 per cent of the flora.

Thus, implantation with *Bacillus acidophilus* was readily effected with lactose or dextrin alone added to the usual diet, with pure cultures of *Bacillus acidophilus*, or with a combination of considerably reduced amounts of the lactose or dextrin and whey cultures.

Pure milk cultures of *Bacillus acidophilus* when taken in sufficient amount have the same transformation influence as young viable whey or broth cultures of the organism. However, preparation of satisfactory milk cultures is attended with considerable difficulty due to the slowness of newly isolated or untrained strains in developing in the milk. This difficulty has been overcome in our laboratory by the use of relatively large amounts of acidophilus culture (inoculum) in the milk. The platinum wire method of inoculation is futile, and

the pipette must be resorted to. At least 2 or 3 cubic centimeters of liquid inoculum or suspension should be employed for every 100 cubic centimeters of milk cultured.¹

BACILLUS ACIDOPHILUS MILK.

After numerous attempts to produce a pure, uniform product of acidophilus milk, a method was devised which proved to be satisfactory and thoroughly practicable, and for at least three years acidophilus milk has been produced in this laboratory for both experimental and therapeutic purposes, though on a small scale, of course. The flask method of sterilization of the milk and of inoculation and ripening has been employed here. However, under the supervision of the laboratory, an attempt has been made at commercial production in bulk, and after several months of experimenting, a uniform and satisfactory product is now available and marketed as a beverage and a therapeutic agent. Many dairies and manufacturers of biological products have undertaken to produce the acidophilus milk but, with very few exceptions, the attempts have resulted in failure, due either to lack of proper facilities and intelligent supervision, or to lack of appreciation of the producers as to the very exacting requirements that are necessary.

Successful commercial production of acidophilus milk depends upon the following: (1) An appropriate and well-trained strain of *Bacillus acidophilus*; (2) proper laboratory facilities; (3) a trained bacteriologist; (4) a supply of fresh milk, either skim or whole; (5) proper equipment in the producing room; (6) an able and reliable operator; and (7) adequate facilities for the cooling and the distribution of the product.

One of the most important factors is efficient scientific supervision and the furnishing of absolutely pure starter for every commercial batch of the milk produced. This requirement alone makes it impossible for many dairies and other plants to produce a thoroughly satisfactory product. Not only are immediate scientific supervision and the furnishing of a pure starter necessary, but some provision must be made for at least one central laboratory to isolate new *Bacillus acidophilus* strains as they are needed, and to select the strains that are particularly appropriate for acidophilus milk production.

One of the most practical methods of obtaining pure strains of *Bacillus acidophilus* is by the usual process of plating and isolating the organism from the feces of white rats, which have been kept for at least three or four days on a high lactose diet. The medium employed must, of course, contain an appropriate carbohydrate, preferably galactose or lactose.

A pure and uniform acidophilus milk possesses a smooth, soft curd. It has a slight but pronounced agreeable odor; it is slightly acid, and resembles, more or less, strictly standard buttermilk. It is not very unlike *Bacillus bulgaricus* sour milk; however, bulgaricus milk tends soon to become very acid, whereas the total acidity of

¹ A full account of the experiments and methods referred to above will be found in the monograph of Rettger and Cheplin, *Treatise on the transformation of the intestinal flora*, Yale University Press, New Haven, Conn.

the acidophilus milk seldom exceeds more than 1 per cent in terms of acetic acid. To most persons the milk is agreeable in taste, and others, who manifest some dislike at first, develop an unmistakable fondness for it. The production and wide use of acidophilus milk as a beverage alone may be expected in the near future, or as soon as the proper methods of manufacture and marketing are installed.

Of greater importance, however, is the use of acidophilus milk as a therapeutic agent. Its favorable influence on various types of intestinal disturbances and related ailments have been demonstrated in this and other laboratories, and in the past two years several articles have appeared in the medical press which thoroughly support in general the claims made by this laboratory.²

PRACTICAL CONSIDERATIONS FROM THE STANDPOINT OF THE DAIRYING INDUSTRY.

From what has been said, it must appear to everyone that the successful commercial production of acidophilus milk on a very large scale should constitute an important outlet for fresh skimmed and for whole milk. Furthermore, the increasingly widespread use of lactose as a therapeutic agent, particularly in connection with the acidophilus milk, has its important bearing on the dairying industry.

Until quite recently many dairies, both large and small, had as one of their major problems the economic disposal of all, or a large part, of the skimmed milk. It is true, of course, that in many instances such milk was used in the manufacture of cheese; but even here the inherent losses through inability to make use of the milk sugar in the discarded whey are very significant.

The feeding of sour milk to poultry, especially to young and growing chicks, the economic value of which was demonstrated in the extensive investigation of Rettger, Kirkpatrick, and Jones (Storrs Agricultural Experiment Station, Bulletin 77, June, 1914), has attained almost universal practice, at least in this country. However, in spite of the diversion of millions of gallons of skimmed milk to this channel annually, the utilization of skimmed milk as such or of desiccated milk still remains a very serious problem.

In past years the chief value of cow's milk has been in the fat which constitutes from $3\frac{1}{2}$ to 5 per cent of the total solid matter of the milk. When we consider that milk contains lactose or milk sugar to the extent of 4 to 5 per cent, and that lactose is one of the most beneficial foods for man, the tremendous losses that have occurred, due to lack of demand for skimmed milk and for cheese whey, must appear to us appalling. In addition to this high percentage of lactose in milk, there is from $3\frac{1}{2}$ to 4 per cent of protein (casein and milk albumin), which in itself constitutes a very important food. This too is lost wherever there is no commercial outlet for skimmed milk. Therefore, any successful project in the complete

² *Bacillus acidophilus* and its therapeutic application, Rettger and Cheplin, Archives of Internal Medicine, 1922, vol. 29, p. 357. The following are some of the authors and their publications in this field: Bass, C. C., Transformation of the intestinal flora, Annals of Clinical Medicine, 1922, vol. 1, p. 25; Southern Medical Journal, 1923, vol. 16, p. 1; Kopeloff and Cheney, Journal American Medical Association, 1922, vol. 79, p. 609; 1923, vol. 80, p. 602; Reddish and Miller, Notes on the therapeutic use of *Bacillus acidophilus*, Virginia Medical Monthly, January, 1923.

carrying out of which a demand is created for skimmed milk and for lactose, should, in itself, be of very great economic importance to the dairy industry.

I might say here that our laboratory does not expect to go into commercial production. We have, however, been assisting one of the dairies in our city to produce the milk commercially. The need for some practical way of supplying the milk to the public in our immediate vicinity has compelled us to serve as supervisors of the production of the milk in one of the leading dairies in the city. The pure starter is furnished regularly by us.

I recall when I first became interested in the problem of diverting waste milk into useful channels. In places that I visited, experiment stations, dairies, etc., where they were skimming the cream off of milk for butter making, hundreds of gallons of skimmed milk were run into the sewer every day. I believe that on the Connecticut farms you will find no skimmed milk wasted now. You will find that the farmers are all anxious to get this milk for poultry feeding. In New England, at least in our own State, skimmed milk is being used to make poultry flesh. But even then, there is still more to be accomplished in the way of saving and using this by-product.

Chairman THATCHER. Is there discussion on this paper or are there questions to be asked Doctor Rettger?

Dr. S. ORLA-JENSEN. I agree with Doctor Rettger that *Bacillus bulgaricus* is not the best bacterium to take to avoid intestinal putrefaction because it is a special milk bacterium and can not thrive without milk, and if you do not drink more milk than you can digest it can not thrive at all in the intestines. It is quite right that you should isolate lactic acid bacteria that occur normally in the intestines if you wish them to grow. But I am not quite sure that the bacterium Doctor Rettger has called *Bacillus acidophilus* Moro is really *Bacillus acidophilus*. This bacillus, in the literature, is very often confused with *Bacillus acidophilus*, and also with lactic acid bacteria. I have had pure cultures from the laboratory in Prague where all such cultures are kept and I have studied it here. I have often found species like this in animals, and I think it is no real lactic acid bacterium. It is not a very strong acid former. The name acidophilus is not a very good name, because most lactic acid bacteria can form much more lactic acid than this bacterium. I think the bacterium with which Doctor Rettger works is rather a bacterium which I have called "Streptobacterium." It is a very strong lactic acid former, not so strong as *Bacillus bulgaricus*, but more resistant and can be used in all different media. You will always find it in cheese, and I should like to say that I think that as a diet cheese is much more important because it will tend to give us in the intestines many good lactic acid bacteria. I should like to say that here in America you ought to eat less meat and more cheese. [Applause.] In cheese you will find very good lactic acid bacteria which can grow in the intestines.

Dr. L. F. RETTGER. I thoroughly agree with Professor Orla-Jensen. About the question as to whether our bacillus should be

called *Bacillus acidophilus* Moro we are not ourselves absolutely assured. Different strains of our organism vary materially. There seem to be almost unlimited varieties or variants. The classification of the so-called aciduric type is still in an early stage. We believe that our organism should be called *Bacillus acidophilus* because it meets so many of the original Moro bacillus requirements. At times you can not make the bacillus grow in the milk at first. With some of our strains you have to use large amounts of inoculum, especially in some of the human strains. However, many strains of *Bacillus acidophilus* can be trained very readily to acidify and coagulate milk.

With the other statement that Professor Orla-Jensen makes, I agree very heartily in the main. I think the real secret in acidophilus therapy is the milk and, most particularly, the lactose. I believe Professor Orla-Jensen must have obtained the impression from this paper that it is the lactose that we are emphasizing chiefly, and it is for this reason that I am here to-day to try to impress upon you the possible use of the lactose in the way I have indicated. Some of you will recall the interesting book by Slosson, published a few years ago, "Creative Chemistry," in which he said that cane sugar is one of the greatest of all foods. I believe that lactose is an infinitely better food. We are quite certain, nevertheless, that acidophilus culture, particularly as acidophilus milk, will hasten the development of *Bacillus acidophilus* in the intestine.

Dr. J. M. SHERMAN (Department of Agriculture). I'd like to ask Doctor Rettger whether the work of Torrey has ever been substantiated. He stated a few years ago that vegetable proteins favored *Bacillus acidophilus* in the intestine, while meat proteins favored the putrefactive types. Has that been substantiated?

Dr. L. F. RETTGER. We have not gone into the feeding of vegetable proteins to any extent; I am, therefore, unable to express an opinion. It was a rather surprising announcement to us that vegetable proteins should favor the establishment of *Bacillus acidophilus*. I do not know whether the claim has been substantiated.

Chairman THATCHER. Is there further discussion of the paper?

Mr. J. J. FREY (California Department of Agriculture). I should like to ask Doctor Rettger if it is true that the effect of lactic acid is dependent on the fact that it is not absorbed to so great an extent in the small intestines and passes down to the large intestine where stagnation often occurs?

Doctor RETTGER. In our experiments we tried to determine why lactose possesses this favorable property. I may say that we have, without difficulty, recovered reducing substances from the contents of the large intestine after lactose feeding. Dextrin also, in part, reaches the large intestine, but according to our observations, cane sugar, malt sugar, and grape sugar do not.

Chairman THATCHER. I think the 10 minutes allowed for discussion of this paper have elapsed. We may be able to go back to the discussion later if it is so desired.

The next paper on the program, that of "The chemistry of casein," will be presented by Dr. L. L. Van Slyke, chief chemist, New York State Agricultural Experiment Station, Geneva, N. Y. Doctor Van Slyke. [Applause.]

THE CHEMISTRY OF CASEIN.

LUCIUS L. VAN SLYKE, Ph. D., chief chemist, New York State Agricultural Experiment Station, Geneva, N. Y.

To discuss with any adequate degree of fullness the chemistry of casein within the limits prescribed for this occasion is an impossibility. It is, therefore, the purpose of this paper to give merely a rather brief summary of most of the divisions of the subject and to select only one or two topics for more detailed consideration. What is, of necessity, omitted is much greater in volume than what is included.

IMPORTANCE OF CASEIN.

Casein is the most important protein in milk, not only because it is the one present in largest amount, but especially because: (1) It has a high food value; (2) its presence makes it possible to convert milk into cheese; and (3) it is finding an increasing multiplicity of applications in the arts, as evidenced by hundreds of patents.

AMOUNT OF CASEIN IN NORMAL MILK.

In the case of mixed market milk, casein usually varies between 2 and 3 per cent. In milk obtained from single herds of cows, casein varies from about 1.80 to over 3 per cent. In the case of single milkings of different individual cows, casein may vary from 1.50 to 4.50 per cent. In the milk of cows which are in advanced stages of lactation and giving only small amounts of milk, extremely high percentages of casein are found, but such milk is properly regarded as abnormal.

(1) *Conditions influencing percentage.*—The percentage of casein in milk is influenced by different conditions, among which are such as the individuality of cows, breed, stage of lactation, time and manner of milking, food, season, etc. For example, in the milk of seven different breeds of cows, studied at the New York Station at Geneva, the average percentage of casein was found to vary from 2.20 in the case of the milk of Holstein-Friesian cows to 3.10 in the milk of Devons.

As between the early and later stages of lactation, the percentage of casein generally increases with advance of lactation, especially after the fourth month. As between the lowest and highest percentages of casein during a lactation period of 10 or 11 months, there may be an average difference of about 0.70 (as from 2.40 to 3.10), which is equivalent to an increase of nearly 30 per cent.

Seasonal conditions furnish another illustration: Thus, in periods of severe drought the casein has been found to decrease in the case of the milk of cows dependent wholly upon pasturage for food supply. This condition is found to be accompanied by a marked increase in percentage of fat along with a severe shrinkage of milk yield.

(2) *Quantitative relations of casein to other milk constituents.*—It used to be stated in literature without any qualification, and universally accepted as a fact, that the amounts of casein and noncasein proteins in milk are present in very constant relative proportions,

the amount of casein being five times that of other proteins. On the contrary, this relation varies greatly. Taking the milk of herds of cows, casein varies all the way from 2.5 to 5.5 parts for 1 part of other milk proteins; and, of course, even greater variations occur, if we consider the milk of individual cows. The average of many milks shows about 4 parts of casein to 1 part of other proteins. This relation varies with individuals, breeds, stage of lactation, and other conditions. In the later stages of lactation, for example, the amount of casein relative to the other milk proteins tends to decrease. There are interesting quantitative relations between casein and fat in milk, which have a distinct practical bearing upon the relation of milk to cheese making and to composition of cheese, and also upon the question of detecting skimmed milk, but time does not permit their consideration.

COMMERCIAL RELATIONS OF CASEIN.

Casein and various forms of preparations made from it are used for many purposes, which can be grouped under two general classes, those used (1) in the arts, and (2) in food and medicinal preparations. We can give only a brief list of these without consideration of the chemistry involved.

The application of casein preparations in the arts is imperfectly summarized as follows: (1) Painting materials. (2) Adhesives, putties, pastes, etc. Adhesive preparations made from casein have, for example, recently found extensive application in the building of those parts of airplanes made by pasting together thin pieces of wood. An extensive use is also found in connection with the application of spraying materials to plants in order to make the material adhere properly. (3) Plastic materials, as a substitute for horn, ivory, celluloid, bone, etc.; in the manufacture of insulating materials, tubes, rods, handles of all kinds, buttons, picture frames, etc. (4) As a medium for fixing colors in textiles. (5) For waterproofing colored papers, art papers, transfer papers, washable wall paper, drawing paper, writing paper, cardboard, boxes, cartridge cases, paper flasks for holding oils, wood-pulp vessels, etc. (6) Mixed with asbestos paper and board, it forms waterproof and fireproof materials. (7) There are, in addition, many miscellaneous uses, among which are paint removers, shoe polishes, photographic plates, roofing pulp, glazing for inside of casks, preparation of artists' canvasses, solidifying mineral oils, soap making, etc.

Special preparations of casein, usually made from skimmed milk, are used as concentrated foods, particularly by diabetic patients. These are sold under various trade names, such as Sanatogen, Eulactol, Plasmon, Nutrose, Lacto-somatose, Sanose, etc. These preparations are usually put up in the form of a fine, white powder and, being alkali caseinates, are readily soluble in water. Some other preparations are mixtures of casein or a caseinate with some form of carbohydrate, such as cereal flours, sugars, etc. Others contain some medicinal agent, as, for example, Sanatogen, which contains five per cent of sodium glycerophosphate. Some of these preparations are made into bread after being mixed with flour in order to increase the protein content. In most cases, uncombined casein is not present, but some of its soluble compounds are used, prepared by

treatment with some solvent, among which can be mentioned sodium bicarbonate, sodium citrate, sodium or potassium phosphate, and some ammonium salts. The percentages of casein in the different preparations vary from 20 to 95.

Casein compounds are found very useful as a means of administering medicinal agents, such as salicylates, alkaloids, lithium, mercury, silver, iron, arsenic, etc. The combination of such substances with casein favorably modifies their irritating or other objectionable properties for medicinal purposes. For example, the silver compound commercially known as Argenin is a white powder, readily soluble in warm water; it is neutral in reaction and is as strongly bactericidal as silver nitrate, but is free from caustic action and is, therefore, well adapted for contact treatment of sensitive tissues.

From this brief summary, it is obvious that the uses of casein are without limit. The source of casein used in these numerous ways is largely the skimmed milk of creameries.

There is one other important commercial relation of casein. The behavior of calcium caseinate in milk to the enzyme contained in rennet lies at the basis of the manufacture of most kinds of cheese. The curd produced by such action, when made into cheese, retains most of the milk fat and a considerable amount of the salts of the milk, especially the phosphates, with smaller amounts of milk sugar and albumin.

PREPARATION OF CASEIN.

Crude commercial casein is prepared from skimmed milk or buttermilk by treatment with dilute hydrochloric or sulphuric acid. The precipitate is washed and drained or partly dried. On an average, 100 pounds of skimmed milk will yield about $8\frac{1}{2}$ pounds of damp casein or $3\frac{1}{2}$ pounds of dry.

The Dairy Division of the Bureau of Animal Industry of the United States Department of Agriculture has perfected a method for preparing casein in dry, granular, although not pure, form, for the purpose of making glue used in airplane manufacture. This work is described in full detail in the *Journal of Industrial and Chemical Engineering*, vol. 12, 1920.

Much attention has been devoted to the preparation of casein in purer form. The difficulties encountered are due chiefly to the adsorptive and occlusive properties of casein. The preparation of pure casein requires the following conditions: (1) Complete removal of the insoluble inorganic salts contained in the milk, calcium and magnesium phosphates; (2) complete removal of the calcium contained in the calcium caseinate of the milk; (3) complete removal of milk fat; (4) control of treatment so as to give an isoelectric product; (5) avoidance of treatment that causes splitting of the casein molecule; (6) separation of the product in very finely divided condition without grinding.

For the purpose of ascertaining the true properties of casein, only strictly pure casein can give reliable results; and it is on this account that so much attention has been given to the preparation of a pure product.

The original method of Hammarsten, who was the pioneer student of the chemistry of casein, is to precipitate diluted skimmed milk

with hydrochloric or acetic acid, filter, wash, dissolve in dilute alkali (ammonium hydroxide or sodium bicarbonate), and then repeat the process, alternately, of precipitation and solution five or six times. The final precipitate is treated with alcohol and ether. This method does not produce pure casein. It seldom contains less than 0.30 to 0.40 per cent of ash, usually much more, which consists of calcium and magnesium phosphates, occluded in the precipitate, and may contain some calcium caseinate. Numerous modifications of this method have been devised, especially for the purpose of removing phosphates. It must suffice for this occasion to describe the method which has been developed in the laboratory of the New York Experiment Station at Geneva, which, in our experience, satisfactorily meets the requirements of preparing strictly pure casein. The details have been published in part in Station Bulletin No. 65 (1918), but essential details more recently worked out have not yet been published, and it is to these later developments that special attention is here called.

Fresh, undiluted, unheated separator skimmed milk is used. Into this is run from a burette a mixture of 1 part of normal hydrochloric acid and 1 or 2 parts of normal acetic acid. The acid is introduced slowly below the surface of the milk, the tip of the tube which carries the acid from the burette into the milk being so arranged that it is near the bottom of the body of milk and very close to a mechanical stirrer, revolving at the rate of about 2,000 revolutions per minute. Under these conditions of slow addition of acid and its quick distribution, the acid does not cause separation of the casein at the point where it first comes into contact with a portion of the milk. All details of precipitation and washing with water in a centrifuge are given in the bulletin mentioned. It is from this point of operation that new features of technique have been introduced. The separated casein is washed with successive portions of water in a centrifuge, until the wash water begins to show slight cloudiness, indicating that the minute particles of casein are going back into suspension and do not, therefore, separate completely in the centrifuge. The casein precipitate still contains some phosphates of calcium and magnesium in colloidal condition, and these compounds can be completely removed only by special treatment. When the washing with water is carried to the final point, indicated by cloudiness of the supernatant wash water, the centrifuged casein mass is beaten back into suspension with water by the stirrer. Then sodium hydroxide of about tenth normal concentration is added until the resulting solution has a neutral reaction indicated by hydrogen ion concentration of pH 7. In this solution of sodium caseinate, the calcium and magnesium phosphates remain in suspension and can be mostly removed by centrifuging. However, enough remains in suspension to give the centrifuged solution a slight opalescence.

The solution of sodium caseinate is diluted so that it contains the equivalent of 1 to 1.5 per cent of casein. This is then precipitated by the same treatment used in the case of the original skimmed milk, except that it is found preferable to add only normal acetic acid, without hydrochloric, to a reaction of pH 4.7. The solution obtained after centrifuging the precipitate is water clear. The casein is finally suspended in water and dilute acetic acid added to

the reaction of pH 4.7. In this suspension, the final trace of phosphates is removed by electrolysis, the suspension being placed in the middle compartment of a three-compartment cell, separated by sheets of collodion. Bacterial action is prevented by toluene. After this treatment is completed, the casein is centrifuged with water and treated, in succession, first with hot, neutral 70 to 80 per cent alcohol, then with absolute alcohol, absolute ether, and finally with petroleum ether of high boiling point, or with benzene or toluene. According to the method formerly used in our laboratory, ether was the final reagent used in making the preparation of casein. It was found that, in spite of precautions, the reduced temperature caused by the rapid evaporation of the ether resulted in condensation of moisture from the air about the particles on the surface of the casein mass. The effect of this condensation is to convert the fine particles of the exposed surface into a sticky, gum-like crust, which can be made sufficiently fine only by grinding. However, if treatment with ether is promptly followed by treatment with some volatile liquid of higher boiling point, the evaporation is slower, there is no condensation of moisture, and the particles of casein retain their extreme fineness.

The reason for treatment with hot 70 to 80 per cent alcohol is the removal of a protein, to which Osborne recently called attention, which we find, so far as it has been studied, possesses properties distinguishing it markedly from casein.

Before publishing the details in the near future, some additional refinements in this method of preparing pure casein are being worked out in order to make control of the method simple and sure in the hands of other workers.

COMPOSITION OF CASEIN.

Casein is a very complex chemical compound belonging to the general class of proteins and to a special subdivision called phosphoproteins. We can conveniently consider the composition of casein under two heads: (1) Ultimate composition; (2) the structure of the casein molecule.

(1) Under this head we take time to refer only to a single constituent, phosphorus. All analyses have given the percentage of phosphorus as 0.85, a figure confirmed by our latest results.

(2) Our present knowledge of the structural composition of any protein is expressed in terms giving the percentage of each of the different amino acids formed by hydrolysis of the protein. The products of such a decomposition of casein have been extensively studied. The detailed results can not be considered in a paper suitable for this occasion, and we can only summarize them by saying that between 15 and 20 different amino acids are contained in the casein molecule, in amounts varying from 0.25 to 22 per cent, and accounting for only about 90 per cent of the total nitrogen, thus indicating the need of more work to make our knowledge complete.

Action of acids.—When isoelectric casein is treated with dilute acids a portion of the acid is concentrated upon the surface of the undissolved particles of casein without forming a chemical compound; that is, acid is adsorbed by casein and the amount varies (*a*)

with the concentration of the acid, (*b*) with the duration of contact and degree of agitation until equilibrium is reached, (*c*) with the temperature, and (*d*) with the kind of acid.

Casein dissolves easily in moderately dilute acids, more easily at higher temperature, forming soluble compounds, which are either combinations of acid with the casein molecule or hydrolytic products, depending on concentration of acid, degree of temperature, length of contact, etc. Knowledge of the compounds of casein with acids is far from complete.

Action of bases on casein.—Casein unites with the bases of fixed alkalies, with ammonium hydroxide, and with the bases of alkali carbonates to form caseinates easily soluble in water. Bases of the alkali earths combine with casein to form caseinates, having differing properties of solubility. In considering the compounds formed by casein with bases, several fundamental factors are involved, such as the equivalent combining ratio of casein, its valency and molecular weight. The literature is considerable and the views rather widely divergent. It is not possible to present them here, even in outline; we can give only a brief summary of what may be regarded as the hypothesis most concordant with such facts as we have at present.

The most probable equivalent combining ratio of casein is about 1,100, and the molecular weight, 8,800, the valency therefore being 8. On this basis there should be theoretically capable of existence 8 compounds of casein with a monovalent base and 4 with divalent bases. Since combination of casein and calcium is of most direct practical interest, we confine our brief discussion to this as typical. On the basis of experimental facts at present known, we can be sure of the existence of one such combination, the octovalent compound, in which 100 grams of casein is combined with 1.78 grams of calcium. This is capable of proof by three lines of experiment. While other preparations have been made in which one, two, and five valencies are used, the method of preparation is such as to occasion some degree of uncertainty in the case of the two latter. Three hypotheses are possible: (*a*) Existence of definite compounds, corresponding to the different degrees of combination possible with octovalent casein; (*b*) the existence of only the octovalent compound, the other apparent unsaturated combinations being actually mixtures of this saturated compound with varying amounts of iso-electric casein; (*c*) the existence of an indefinite number of colloidal combinations.

When, for example, to a solution of casein in calcium hydroxide we add known amounts of acid, dialyze, and precipitate with alcohol, we can obtain preparations of varying composition which are practically numberless. Such preparations vary in properties. Within certain limits of hydrogen ion concentration, marked colloidal properties appear. These are being studied. The use of electro-metric titration in determining points of dissociation, as the evidence of definite compound formation, affords hope of reaching some definite conclusions, together with a study of the surface and interfacial tension of caseinate solutions.

This paper, though very incomplete, has already reached the assigned limits, but a brief reference, before concluding, will be made

to the action of the enzyme contained in rennet extract, leaving untouched other interesting phases of the chemistry of casein. The colloidal relations of casein in milk we have omitted because this forms an essential part of the paper coming next on the program.

The action of rennet enzyme in the coagulation of calcium caseinate in milk is believed to take place in three quite distinct stages: (a) Change of calcium caseinate into uncoagulated calcium paracaseinate; (b) change of calcium salts in the milk into soluble form, which may be greatly increased by the action of acid-forming bacteria or by direct addition of acid; (c) precipitation of the uncoagulated calcium paracaseinate by the soluble calcium salts. The numerous, interesting, and essential details of conditions involved in these stages of change we can not take time to describe.

The protein, casein, is probably split into two molecules of paracasein, which therefore has a molecular weight of 4,444 and a valency of 4. Paracasein forms salts similar to those formed by casein.

In conclusion, it may be said that casein still forms and will, for a long time to come, a subject of great interest for research workers, whether in relation to its pure chemistry or its numerous applications to various needs of mankind.

Chairman THATCHER. Is there discussion of the paper presented by Doctor Van Slyke?

Dr. J. M. SHERMAN (Department of Agriculture). I'd like to ask Doctor Van Slyke what he thinks of the recent methods published by Northrup.

Doctor VAN SLYKE. Doctor Northrup gave no adequate results in his paper. My feeling is that that work is incomplete.

Mr. S. K. ROBINSON. I'd like to ask Doctor Van Slyke whether the cause for the plastic properties that occur when cheese is mattered can be explained by physical, colloidal, or chemical changes.

Doctor VAN SLYKE. I will answer that question by telling you I don't know. That is the only answer I can give. We are engaged in studying that.

Mr. S. K. ROBINSON. Then, referring to the physical changes that cheese undergoes through the first month of curing there is a chemical change there by which the total nitrogen will change from 100 per cent insoluble to approximately 95 per cent insoluble. During that time there is a distinct change in the body of the cheese. It goes from a hard rubbery mass to a smooth mass, or comparatively so. Is there any way that can be explained?

Doctor VAN SLYKE. I will have to answer that just the same as I have the first. We understand the chemical change—that breaking off of calcium that goes into the cheese is taking place and the plastic properties are being lost in proportion as the calcium is being broken off from the calcium caseinate. The question is just exactly like the first, and the two questions are involved in the same explanation. As to why, I can't say, and I know no man on earth who can.

MEMBER. I would like to ask Doctor Van Slyke if he can tell me why, in making casein with the acid it will come out white and if you use rennet it is colored?

Doctor VAN SLYKE. That is a problem we have not studied.

MEMBER. I have tried it and it becomes white when acid is used, and by using rennet it turns brown.

Doctor VAN SLYKE. In what condition is your casein in respect to color?

MEMBER. It is slightly tanned. You appreciate it takes only a small amount of rennet to precipitate color.

Chairman THATCHER. Doctor Palmer is not here. His paper will, by the regular order of procedure, pass to the foot of the list.

Doctor Laxa, director, Bacteriological Institute, Polytechnic School, Prague, Czechoslovakia, is not present. His paper will also be read by title.

There has been handed in a series of papers by Doctor Sato, of the Hokkaido Imperial University, Sapporo, Japan. The first one is, "On fat phagocytosis of leucocytes," which Doctor Sato will read. [Applause.]

ON FAT PHAGOCYTOSIS OF LEUCOCYTES.

MASAYOSHI SATO, D. Sc., professor, Hokkaido Imperial University, Sapporo, Japan.

Investigations were made on the origin and function of the colostrum corpuscles from the histological, chemical, and biological points of view. As the material for his biological study, the writer, after injecting milk into the abdominal cavity of a guinea pig, and the dorsal lymph sacs of a frog, took out abdominal fluid from the former, and serum fluid, mixed with milk and blood, from the latter, and made vital staining with methylen blue, Giemsa's and Ruzicka's stains. Then, by adding the physiological salt solution to the abdominal fluid, obtained by injecting beef extract into the abdominal cavity of the guinea pig; and also to the leucocytes obtained from the vesicles that were induced by coating the sides with cantharidis, after the hair was taken off, he made the emulsion of leucocytes and investigated the fat phagocytosis thereof.

Through the investigation the writer confirmed the fact that the fat phagocytosis of leucocytes was caused by injecting milk into the abdominal cavity of a guinea pig. The leucocytes were found filled with small milk globules of uniform size in some cases, and of varying sizes in other cases; these globules could hardly be distinguished in appearance from the milk globules usually found in the milk of lactation and the end milk. However, it was not demonstrated whether these phenomena were to be attributed to the facile combination among the leucocytes of small fat globules or to the subdivision of corpuscles after they were combined by the leucocytes, as some investigators have stated.

As a result of fat phagocytosis, the leucocytes increased in size, the smallest one being $16\ \mu$ in diameter, while the larger one was $34.2\ \mu$. So far as the writer's study on various occasions was concerned, the usual size of the leucocytes of guinea pigs, including small lymphocytes, large mononuclear leucocytes, transitional leucocytes, and polymorphonuclear leucocytes, was, on an average, $3.6\ \mu$ in the smallest one, and $18\ \mu$ in the largest one. Leucocytes of $16\ \mu$ were found most numerous. This would seem to indicate that the leucocytes were increased by fat phagocytosis in size to two or three

times their diameter; the fat globules reached sometimes 40 μ and more in size.

In the case of the polymorphonuclear leucocytes, the nuclei, being affected by fat phagocytosis, were pressed to one side by the fat globules. They were combined, assuming the aspect of mononuclei, or were separated from one another. In case the effect of fat phagocytosis was great, the nuclei generally were not discernible by vital stain, and no distinction could be made between large mononuclear leucocytes and polymorphonuclear leucocytes.

In the case of large mononuclear leucocytes, the nuclei were also pressed into somewhat irregular sizes, and could hardly be discerned from the combined nuclei of the large mononuclear leucocytes; these latter, however, could be distinguished by a lighter color and also by a close inspection.

It was demonstrated, as Cohn has stated, that the neutrophil granules in the polymorphonuclear leucocytes gradually disappeared as fat phagocytosis progressed, but it was not clear whether they would completely disappear or whether they would combine under the pressure exerted.

Fat phagocytosis was seen in the large mononuclear leucocytes, transitional leucocytes, and polymorphonuclear leucocytes, but that action, by which the size of the nuclei was changed, like that of the colostrum corpuscles taking in numerous fat corpuscles of all sizes, was usually seen in the large mononuclear leucocytes. The eosinophil leucocytes seldom presented fat phagocytosis while the small lymphocytes presented none.

Regarding the fat phagocytosis of the leucocytes produced by injecting milk into the dorsal lymph sacs of frogs, the same action was found as in the case of the leucocytes produced by injecting milk into the abdominal cavity of guinea pigs.

The fat phagocytosis of the leucocytes could be tested in vitro in the same way as in vivo, and its various functions could also be inspected. The fat index of the leucocytes showed its minimum in the physiological salt solution, both in the case of mononuclei or polymorphonuclei, the order of each composition being milk serum, albumen, inactive serum, milk, serum of colostrum milk, and active serum; and, no matter what these substances used as complement might be, the opsonic index of the leucocytes was greater in the case of the unwashed milk-fat globules than in the case of the washed milk-fat globules. This was perhaps due to the unwashed milk-fat globules' easily adhering to the leucocytes. In short, the opsonic index of the leucocytes in vitro enhanced the vitality of the leucocytes, and was found high when a medium that would make the milk-fat globules easily adhere to the leucocytes was employed; this differed from the case of bacteria in vivo, and at the same time proved that azoosonin was not present in the serum.

Through some experiments made on the leucocytes taken from calves it was confirmed that the same result could be obtained as in the case of guinea pigs.

Chairman THATCHER. Doctor Sato has four other papers, the titles of which I will read presently. There has also been a paper added to the program by Doctor Hauser, of Austria. We regret the hour

is getting so late, but we would be very glad to have Doctor Hauser present his paper to this small group. Doctor Hauser represents the Government of Austria, and he will present his paper concerning a new method of defining the water content of milk powder and the properties of its colloidal constituents.

EINE NEUE METHODE DER BESTIMMUNG DES FEUCHTIGKEITSGEHALTES VON MILCHPULVER UND DES ZUSTANDES SEINER KOLLOIDALEN BESTANDTEILE.

ERNST A. HAUSER, Ph. D., Leiter der kolloidchemischen Abteilung der Metallbank in Frankfurt-am-Main, beratender Chemiker der K. D. P. Ltd., London.

Herr Vorsitzender, meine Damen und Herren: Es ist eine Erfahrungstatsache, dass nackte Zahlen und rein theoretische Ueberlegungen in einem wissenschaftlichen Vortrag ermüdend wirken und ich will Sie daher damit nicht belästigen. Ich will Ihnen nur zeigen, dass auch die jüngste unserer Wissenschaften die Kolloidchemie im Chemismus der Milch eine grosse Rolle spielt und die Kenntniss ihrer Gesetze nutzbringend angewandt werden kann. Wenn es mir daher gelingt, in Ihnen Interesse für diesen Zweig unserer Wissenschaft in Bezug auf Milch zu erwecken, so ist mein Zweck erreicht.

Ich las vor einiger Zeit eine unveröffentlichte Arbeit von Hans Czerny, der festgestellt hatte, dass Milchpulver beim anteigen mit Wasser eine bedeutende Temperaturerhöhung erfährt. Diese Bemerkung veranlasste mich, den Grund dieser Erscheinung näher zu studieren.

Für die Versuche wurde Milchpulver verschiedener Herstellungsart und Provenienz verwendet. Die Versuche selbst wurden folgendermassen ausgeführt. In einem Thermostaten wurden zwei Eprouvetten eingehängt, von denen die eine mit destiliertem Wasser, die andere mit 5 Gramm Milchpulver beschickt wurde. In die letzere wurde ein Beckmannthermometer (0.1°) eingelegt. Sobald Temperaturengleich eingetreten war, wurden mit Hilfe einer Pipette 2 ccm. des destilierten Wassers auf das Milchpulver aufträufeln gelassen und dieses mit dem Thermometer durch langsames auf- und abbewegen angeteigt. Gleichzeitig wurde die Temperaturerhöhung festgestellt und das Maximum, welches meistens in 1 Minute erreicht war, notiert. In einer Probe desselben Pulvers wurde auf gewöhnliche Art der Wassergehalt bestimmt. Die so erhaltenen Zahlen wurden in ein Koordinatensystem eingetragen und durch eine Kurve verbunden. (Milchpulver mit einem Feuchtigkeitsgehalt unter 0.5 Prozent wurde durch trocknen im Hochvakuum erhalten, Pulver mit einem Gehalt über 2 Prozent durch Belassung in einem Exsiccator, der mit Schwefelsäure verschiedener Konzentration gefüllt war.)

Kurve I zeigt Ihnen das Ergebnis einer Versuchsreihe mit "Zerstäubungspulver." Diese Kurve war für Pulver gleicher Provenienz derart genau, dass wir seither in unseren Laboratorien die Bestimmung des Feuchtigkeitsgehaltes nach dieser einfachen und raschen Methode machen. Die Fehlergrenze wurde zu ± 0.1 Prozent gefunden.

Wenn wir die Kurve genauer betrachten, so bemerken wir, dass sie bei einem ursprünglichen Feuchtigkeitsgehalt des Pulvers von circa 3.5 Prozent einen Knick anweist. Was ist die Ursache?

Das Kurvenstück von 0.0–3.5 Prozent beziehungsweise die hiermit übereinstimmende Temperaturerhöhung ergibt sich aus der Summe der Quellungswärme der in Milchpulver vorhandenen Eiweisskolloide und der Hydratationswärme des Milchezuckers. Es sei hier nur nebenbei bemerkt, dass der Milchezucker im "Zerstäubungspulver" in amorpher Form vorliegt, was durch Betrachtung im Polarisationsmikroskop leicht nachweisbar ist. Bei 3.5 Prozent Feuchtigkeitsgehalt sind die Eiweisbestandteile bereits ziemlich angequollen, sodass von dieser Reaktion keine wesentliche Temperaturerhöhung zu erwarten ist. Der Milchezucker hat bereits sein gesamtes Kristallwasser gebunden und ist von amorphem in den kristallisierten Zustand übergegangen. Bei noch höherem Wassergehalt tritt nun eine dritte Reaktion in den Kreis unserer Betrachtung und zwar

ANHANG

TABELLE

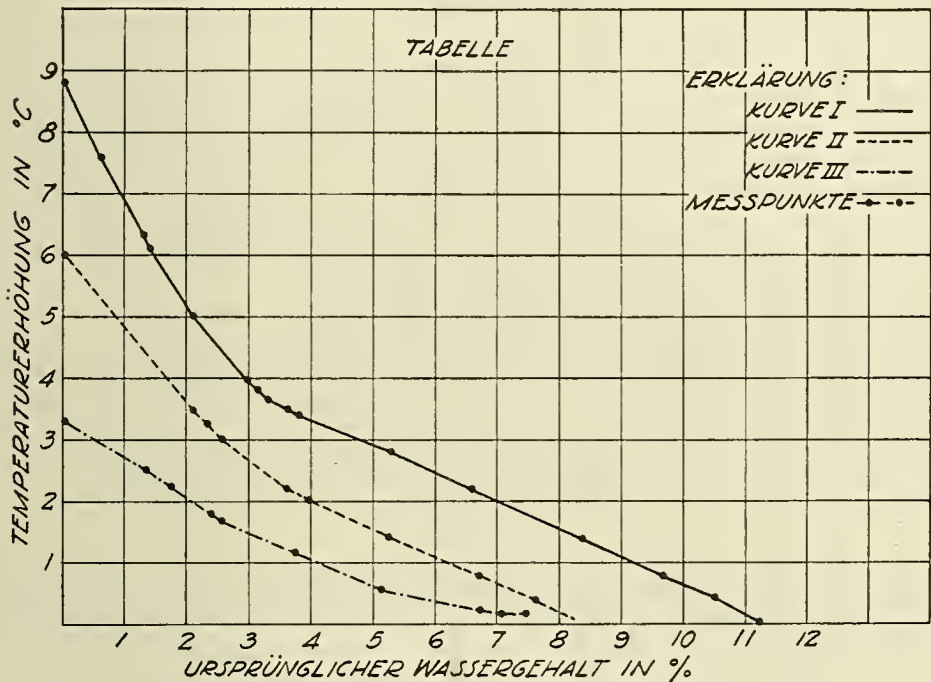


FIG. 1.—Einfluss des Feuchtigkeitsgehaltes verschiedener Milchpulver auf die Temperaturerhöhung.

die negative Wärmetönung, welche durch die Auflösung der in der Milch vorhandenen Mineralsalze hervorgerufen wird. Wir können daher den zweiten Teil der Kurve als Differenz der positiven Quellungswärme und der negativen Auflösungswärme bezeichnen.

Nehmen wir nun ein anderes Pulver, zum Beispiel "Walzenpulver" und führen dieselben Versuche aus, so erhalten wir ein Kurvenbild II. Die Kurve läuft im Grossen und Ganzen parallel zu I, nur mit dem Unterschied, dass die maximale Wärmetönung nicht an I heranreicht. Der Grund hierfür liegt darin, dass ein Teil der Eiweisskolloide durch den Walzenprozess koagulierte und daher nicht mehr quellfähig ist. Kurve III zeigt das Ergebnis der Untersuchung eines Walzenmilchpulvers schlechter Provenienz. Hier ist durch Ueberhitzung an den Kontaktflächen fast das gesamte Eiweiss im koagulierten Zustand vorhanden. Ausserdem hatte dieses Produkt

bereits vor dem Versuch viel Wasser angezogen und es war nicht mehr möglich durch Vakuumtrocknung den Milchzucker seines gesamten Kristallwassers zu berauben.

Welchen Wert hat nun dieses Kurvenbild? Es ermöglicht, wenn sorgfältig ausgearbeitet Jedermann rasch, einfach, und ohne weitere Kenntnis chemischer Manipulationen den Wassergehalt von Milchpulver zu bestimmen. Dies erscheint mir vor allem dort wichtig, wo grössere Mengen Pulver (nicht luftdicht verpackt) lagern, da der Verkäufer immer trachten muss, dass Pulver in den Handel zu bringen, bevor es 5 Prozent Wassergehalt überschritten hat, da sonst für einwandfreie Ware nicht garantiert werden könnte.

Für den Wissenschaftler hat die Methode den Vorteil, dass sie ihn in einfacher Weise und ausserordentlich rasch über den Zustand der Milchkolloide Aufschluss gibt. Es ist ja für den, der in der Thermo- und Kolloidchemie zu Hause ist keine all zu grosse Schwierigkeit die Wärmetönung der in Frage kommenden drei Reaktionen theoretisch zu errechnen und so eine Idealkurve zu konstruieren. Die Abweichung der empirisch gefundenen Kurve ist dann ein Gradmesser für die Veränderung des kolloidalen Zustandes. Die Wichtigkeit dieser Feststellung für den Forscher und die Schlüsse die daraus für den Trocknungstechniker zu ziehen sind, sind wohl einleuchtend, wenn man bedenkt, dass zum Beispiel die Löslichkeit, der Geschmack, die Bekömmlichkeit und viele andere Faktoren, Funktionen des kolloidalen Zustandes sind.

Die Arbeit wird mit feinsten Hilfsmitteln physicochemischer Messmethoden (Thermoelemente, etc.), fortgesetzt und wird in der Zeitschrift, "Le Lait," in extenso veröffentlicht werden.

Der experimentelle Teil wurde unter meiner Anleitung von H. Hering in den Laboratorien der Rohstoff-Trocknungs-Gesellschaft, Frankfurt-am-Main im Sommer 1923 ausgeführt. [Applause.]

[Abstract.]

A NEW METHOD FOR THE DETERMINATION OF THE WATER CONTENT OF MILK POWDER AND THE PROPERTIES OF ITS COLLOIDAL CONSTITUENTS.

ERNST A. HAUSER, Ph. D., head of the department of colloidal chemistry, the Metallbank, Frankfurt-on-Main; consulting chemist, K. D. P., Ltd., London.

When water is added to powdered milk there is an appreciable temperature rise. This temperature rise was determined upon various powdered milks at various moisture contents as follows: Two glass tubes, one containing 5 grams of milk powder and a thermometer (graduated to 0.1°) and the other containing distilled water, were placed in a constant temperature bath. When the tubes had reached constant temperature 2 cubic centimeters of the distilled water were added slowly to the milk powder and the contents mixed with use of the thermometer. The maximum temperature rise was noted. When the moisture content (as abscissa) is plotted against temperature rise (as ordinate) a curve is obtained for a powder, by means of which the moisture content can be determined accurately to 0.10 per cent from the temperature rise.

The temperature rise with powders of 0 to 3.50 per cent moisture content is due to the heat of swelling and the heat of hydration of lactose. At 3.50 per cent moisture there is a break in the curve. Above 3.50 per cent moisture there is a negative heat reaction due to the solution process of mineral salts. The curve at higher moisture contents, therefore, represents the difference between the heat of swelling (positive) and the heat of solution (negative).

Chairman THATCHER. Is there discussion of Doctor Hauser's paper? We regret it was not in time to appear on the printed program. I am sure a larger number of people would certainly have been glad to remain to hear it.

We thank you very much, Doctor Hauser.

Is there further discussion to come before the session before we adjourn?

There are several remaining papers which will be read by title and printed in the proceedings.

(Adjournment.)

(Papers read by title):

THE CHEMISTRY OF MILK AND DAIRY PRODUCTS FROM A COLLOIDAL STANDPOINT.

LEROY S. PALMER, Ph. D., professor of agricultural biochemistry, University of Minnesota, and dairy chemist, Minnesota Agricultural Experiment Station, University Farm, St. Paul, Minn.

The microstructure of milk and its products offers a new and fascinating field for research. Many of the important problems in dairy chemistry, both those of theoretical interest as well as those of practical importance, are colloidal problems. In fact, there is scarcely any phase of the chemistry of milk and its various products to which one can turn without being confronted with colloidal phenomena.

Milk not only represents a complex colloidal system, but, in addition, is one of the few examples of a natural biological emulsion. It is true that the dispersion of fat in milk is in the microscopic, not the ultra-microscopic realm. Nevertheless, such a close relation exists between permanent microscopic emulsions and colloidal particles that no consideration of the colloidal problems of milk and its products can be complete without reference to a few of the many interesting phenomena in emulsion chemistry which the field of dairy technology affords. The literature regarding the colloid problems in dairy chemistry has recently been reviewed in some detail by Clayton (1). The subject, however, is of sufficient importance to warrant a recapitulation of some of its more important features as well as to point out some of the recent advances in the field.

MILK.

Structure.—Structurally, milk consists essentially of a microscopic dispersion of fat in an aqueous plasma containing molecularly dispersed sugar (lactose) and certain mineral salts, and colloidally dis-

persed proteins, of which calcium caseinates and lactalbumin predominate, as well as a colloiddally dispersed calcium phosphate, $\text{Ca}_2\text{H}_2(\text{PO}_4)_2$ (2). The important colloids of milk, therefore, are calcium caseinates, lactalbumin, and neutral dicalcium phosphate. It is not likely that the colloidal lactoglobulin and alcohol-soluble protein play important rôles in the physical-chemical structure of normal cow's milk, except in the case of colostrum, which is rich in globulin. The casein content of normal cow's milk varies between 2.25 and 2.75 per cent, that of lactalbumin between 0.5 and 0.7 per cent, while the $\text{Ca}_2\text{H}_2(\text{PO}_4)_2$ comprises slightly less than 0.2 per cent of the milk. Inasmuch as pure isoelectric casein will disperse in pure water to the extent of only 0.01 per cent, it has been assumed by some that the high percentage of casein in milk is due to the protective action of the lactalbumin. This assumption fails to take into consideration the fact, as shown by Van Slyke and Bosworth (2), that casein exists in milk as calcium caseinate, a compound capable of dispersing in water to form highly concentrated colloidal solutions. Van Slyke and Bosworth believe that this compound is tetra-calcium caseinate, but inasmuch as this particular caseinate appears to be formed only at pH values of 8 to 10 (neutrality is indicated by phenolphthalein), it seems likely that the calcium caseinate occurring in milk at its natural pH of 6.5 is a mixture of the basic tetra-calcium caseinate with a more acid calcium caseinate (3).

The casein and calcium phosphate compounds which are colloiddally dispersed in milk may be readily and completely filtered out of milk by ultra filters of relatively large porosity, thus indicating that their degree of dispersion is relatively coarse. There is also every reason to believe that the calcium caseinate is highly hydrated, although no experiments have so far been reported to show the amount of water which is bound to this colloid in milk. Although the casein molecule is undoubtedly a very large one, it is not likely, as Robertson has pointed out (4), that even the largest possible casein molecule has a sufficient diameter to scatter the light particles and cause the opalescence of casein solutions, particularly the solutions of the calcium caseinates. The aggregation of the calcium caseinate molecules existing in milk which is thus indicated does not, however, preclude the possibility that they are also more or less highly hydrated.

It seems to have been definitely shown that the colloiddally dispersed lactalbumin of cow's milk exists uncombined with base (5). That it is highly hydrated is shown by its almost water-clear solution in the milk serum free from casein as well as by the ease with which the greater part of it may be dehydrated and coagulated by heat. That this protein in milk is in a very highly dispersed state, much more so, in fact, than the other two important colloids of the plasma, is shown by unpublished experiments of the writer who finds it is necessary to construct an ultra filter of very fine porosity to prevent the dialysis of appreciable quantities of heat-coagulable protein from cow's milk.

The factors determining the stability of the three principle colloids of milk have not been thoroughly studied. No doubt, each of the proteins contributes to the stability of the colloidal calcium phosphate, but there is no evidence as to which exerts the greater effect

because the gold number of neither lactalbumin nor calcium caseinate has been determined. It is true that Zsigmondy has assigned a gold number of 0.01 to casein but this is for an ammonium caseinate sol which does not exist in cow's milk. No important technical problems have yet arisen which involve the stability of the lactalbumin sol. However, the stability of both the calcium caseinates and calcium phosphate is a matter of considerable importance in certain operations like the sterilization of evaporated milk. Evidence is rapidly accumulating (6) to show that the character of the mineral salts of milk, and the chemical relations between these and the calcium caseinates of milk, are of considerable importance in determining the stability of the colloidal casein compounds. The idea that the lactalbumin of the milk plays the all-important rôle in this stability thus loses ground. It is now well known that salts exert profound effects on the stability of emulsoid sols. Milk is particularly rich in a variety of inorganic ions. The effect of changes in the equilibria between these ions on the stability of the casein compounds in milk offers a very fruitful field for investigation.

Secretion.—The secretion of milk, that is, its actual elaboration as a finished product from the mammary cells, is largely a colloidal phenomenon, as has been pointed out by Fischer and Hooker (7). The functioning mammary cells, through processes of synthesis and selection from the blood, form a concentrated, complex, protoplasmic gel containing molecules of salts, lactose, and numerous other substances, and molecules and molecular aggregations (colloids) of milk fat and the milk proteins. In the course of the complex chemical reactions taking place some products are formed which cause the cells to imbibe water. Whether this is the increase in the hydrogen ion concentration which must occur if we are to explain the Sørensen value of 6.5 which is natural to milk, or is due to the formation of the sodium and potassium citrates which are present in cow's milk, may be disputed. At any rate, as Fischer explains, the histological as well as actual result is a tremendous imbibition of water resulting in a coalescence of the fat particles into microscopic drops as well as the production of the resulting physical state of the proteins and calcium phosphate of the milk. The general features of this phenomenon can not be doubted. The explanation of the origin of the colloidal dicalcium phosphate as well as the reaction which causes the imbibition of water offers an interesting field for physiological research.

Creaming.—The more or less permanent dispersion of the fat globules in milk is due apparently to a concentration of the plasma colloids at the fat globule-plasma interface. According to Clayton (8), Wiegner has calculated that 2 per cent of the casein of ordinary milk is adsorbed at this interface. It is not likely, however, that the adsorbed film consists wholly of calcium caseinate, since colloidal lactalbumin and calcium phosphate also occur in the plasma. The relative proportions of these colloids adsorbed at the surface should be somewhat in proportion to their ability to lower surface tension, rather than in the proportion in which they occur in milk. This property of the milk colloids has not been measured.

The fact that the fat globules readily rise on ordinary milk to form a cream layer is due primarily, of course, to the difference be-

tween the specific gravity of milk fat and the plasma in which it is dispersed. The ability of milk to form a distinct cream layer of considerable depth is, however, subject to considerable variation, which assumes an economic importance in the case of bottled milk in the market-milk industry of the United States. This is an especially interesting problem because this milk is almost uniformly standardized to a fat content of approximately 3.5 per cent.

In order to obtain the optimum volume of cream on standardized market milk, the rise of fat globules to the surface must be exhaustive, and the risen fat must occupy the largest possible volume which the plasma will permit. It is well known that the size of the fat globules can be a significant factor in determining the exhaustiveness of creaming, as exemplified by the fact that homogenized milk will not form a cream layer. An explanation of this phenomenon is that the increased dispersion of the fat causes an increased interfacial tension which is relieved by an increased concentration of plasma colloids at the interface. This great increase of substances of higher density at the surface prevents the fat globules from rising.

A somewhat different view of the significance of the fat globules themselves in creaming is taken by Rahn (9) who believes that variations in the creaming of cow's milk are due largely to variations in the clumping of fat globules. The writer does not believe that this is of major importance, particularly in connection with the detrimental effect of Pasteurization on the creaming of market milk (10) for which no adequate explanation has been advanced.

A study of the fundamental factors governing the creaming of market milk has been undertaken by E. O. Anderson and J. C. Hening, in the writer's laboratory. Space will not permit the consideration of the detailed results, but a few of the results may be indicated. The experiments have been carried out in all cases with milk containing a standard fat content of 3.5 per cent.

In the case of raw milk the exhaustiveness of creaming as well as the volume occupied by the risen fat in general is correlated directly with the viscosity and therefore with the content of serum colloids. Consequently, on a uniform fat basis, Jersey or Guernsey milk has better creaming qualities than Holstein milk because of the higher protein content of the former. Certain observations of Rahn (9) also support this relation, for he found that the addition of colloidal substances like gelatin led to a quicker as well as a more exhaustive creaming. In fact, he found that the addition of such substances restored the creaming power of heated milk, even that which had been boiled. Physical factors which increase the viscosity of milk, such as low temperature, also have an especially pronounced effect in increasing the volume occupied by the risen fat. This fact has its application in the use of ice water temperature in the creaming of bottled milk.

The relations between viscosity, hydrophilic colloid content, and creaming do not seem to hold true, however, in the case of milk whose normal cream properties have been affected by Pasteurization. The effect of Pasteurization on creaming does not seem to be an effect on the viscosity, for heat affects the milk of all breeds of cows regardless of its protein content. At the same time, the effect of the heat is undoubtedly on the plasma colloids, rather than on the fat

globules themselves, because practically no cream at all will rise when the plasma part of the milk only (skimmed milk) has been Pasteurized, even when the temperature of Pasteurization is too low to have an appreciable effect on the creaming of whole milk. The presence of the fat globules in whole milk actually seems to protect the milk against the detrimental effects which Pasteurization exerts on creaming. It will be interesting to reconcile these results with those of Rahn, who restored the creaming of boiled milk by the addition of hydrophilic colloids.

In a study of the relations of the individual colloids of milk to creaming it has been found that artificial calcium milks cream nearly normally when raw, but have their creaming *adversely* affected by Pasteurization. Lactalbumin milks, made by adding raw cream of high fat content (50 to 60 per cent) to whey, also give excellent cream volumes, and these are invariably *increased* by Pasteurization. These results point to the fact that a change in the casein rather than in the lactalbumin is the predominant factor in decreasing the creaming ability of milk by Pasteurization.

Coagulation.—All of the ordinary factors causing coagulation of milk, namely, heat, acid and rennin, are factors affecting the stability of the colloidal state. Milk coagulation is, in fact, the destruction of the physical state of its chief colloids, calcium caseinates, lactalbumin, and calcium phosphate.

When milk is boiled there is usually no visible coagulation although the lactalbumin and lactoglobulin have, for the most part, been denatured and dehydrated to the point of coagulation. The failure of this coagulated portion to precipitate is evidently due to the protective action of the calcium caseinates. This coagulation is of importance in the production of the proper "liver" secured by superheating the evaporated milk in the pan at the end of the evaporation process. This coagulation also occurs in the drum or roller process of drying milk (11).

The heating of milk also decreases the stability of the colloidal dicalcium phosphate, causing a more or less copious precipitation of phosphates. As the writer (12) has pointed out, it is not necessary to assume a transformation of soluble into insoluble phosphates to account for the precipitation of calcium phosphate when milk is heated. Colloidal dispersions of dicalcium phosphate readily give up their dispersed phase on heating.

Heat has no visible effect on the calcium caseinates of ordinary milk, up to and considerably beyond the boiling point. However, the formation of the calcium caseinate scum when milk is boiled, as well as the change in the hydrophilic properties of the casein (13), and the failure of milk to react normally toward rennin, all point to the fact that heating does affect this colloid. When whole milk or evaporated milk is sterilized, the casein will coagulate at a temperature of 120° to 130° C., depending on the time of heating, and in the case of whole milk (6), on certain as yet undefined relations between the mineral salts and casein compounds of the milk. The coagulation is an irreversible one, as in the case of the heat coagulation of the lactalbumin, but whether the aggregates are pure casein or coagulated calcium caseinate, such as can be secured by the addition of alcohol, has not been determined. There is still much to be

learned regarding the effect of heat on the hydrophilic colloids of milk.

The coagulation of milk with acid involves only the calcium caseinates and the dicalcium phosphate, the latter becoming molecularly dispersed as acid calcium phosphate and as the calcium salt of the acid involved in the precipitation of the casein. Acid coagulation of the calcium caseinates, both that due to natural souring and direct acidification, is caused by the aggregation of the decalcified colloidal particles. The optimum acidity, now well established, is at the isoelectric point of casein, namely, $\text{pH}=4.6$. This fact, together with the physical character of the colloidal aggregates at various temperatures, has found application in the devising of a strictly scientific method (14) for the commercial manufacture of casein for industrial purposes.

The coagulation of milk by rennin is probably its most interesting colloidal phenomenon. Many theories have been advanced to explain the process, but none has found general acceptance. These theories have ranged from purely chemical explanations (15) to strictly colloidal hypotheses, such as those of Alexander (16), and Schryver (17). Alexander's explanation of the rennin coagulation is based on the assumption that the stability of the colloidal dispersion of the casein in cow's milk is due solely to the protective action of the lactalbumin. The rennin clot, according to this view, is merely a case of the destruction of a colloid protection with the probable simultaneous production of coagulating substances.

Schryver's view of the rennin coagulation is similar although expressed in somewhat different terms. He assumes that the colloidal state of the casein compound in milk is due to protective substances adsorbed on the surfaces of the colloidal particles. He believes that the rennin in some manner clears the surfaces of these protective substances, thus permitting the coalescence and precipitation of the casein.

Both of these purely colloidal theories of the rennin coagulation are shown to be impossible by the observation of the writer that perfectly stable colloidal suspensions of calcium caseinate can be prepared without the presence of other protective colloids. Moreover, these calcium caseinate milks, in the proper concentration and when brought to the proper Sørensen value of 6 to 6.5, in the presence of a trace of calcium ions, show a normal rennin clot which exhibits all the properties of syneresis, etc. These gels, however, lack the firmness of normal rennin gels, showing that this property is contributed in part by the other constituents of natural milk.

The chemical properties of calcium paracaseinate (18), as the product resulting from the action of rennin on calcium caseinate is called, indicate that the rennin coagulation is both chemical and colloidal. These two phases of the reaction are independent, as shown by a number of facts which a lack of space will not permit us to review. The chemical reaction appears to consist of a hydrolytic cleavage of the calcium caseinate compounds into 2 molecules of calcium paracaseinate. The clot which forms is caused by the instability of the colloidal paracaseinate compounds under certain conditions, the most important being the presence of calcium ions and a proper Sørensen value of the fluid.

Calcium ions may also play a part in the chemical cleavage of the casein, but just what this may be is not clear. The gelation of the calcium paracaseinate is not merely a precipitation of insoluble protein. At least, this is true at the temperature employed for rennin coagulation in the manufacture of Cheddar cheese where the clot partakes of the nature of a colloidal crystallization similar to the fibrin coagulation of the blood. As in the blood clot, a syneresis also occurs.

CREAM.

The most important colloidal property of cream is its ability to form a firm, stable emulsion with air on whipping. Whipped cream has an unusually interesting structure consisting as it does of an artificial air-in-water emulsion, the aqueous phase of which is itself a concentrated oil-in-water type of emulsion.

The two qualities which are sought in whipped cream are consistency and stability. The desired consistency is determined largely by the percentage of fat in the cream, although the fineness of dispersion of the air particles probably contributes to this property because of the increase in density which suspensoids undergo on subdivision. The actual whipping quality of cream, however, is determined by the hydrophilic colloids of the cream plasma. Most of the variations in the whipping quality of cream are to be explained by the fact that these colloids are required to perform the double function of stabilizing the oil-in-water (cream) emulsion as well as the air-in-water (whipped cream) emulsion. It is a well-known fact that almost all the practical methods employed for increasing the whipping quality of cream, such as low temperature, addition of whipping substances, etc., are either agents which increase the viscosity of hydrophilic colloids, or are themselves hydrophilic colloids, or contain them in abundance.

Many interesting colloid problems are suggested by the double function which the milk proteins perform in whipped cream. The failure of fresh cream as well as that of homogenized cream to whip are both problems of this nature. The first case is probably to be explained on the grounds that many colloids which will stabilize an oil-in-water emulsion can not stabilize an air-in-water emulsion. The milk plasma colloids apparently do not possess this property to such a great extent when the milk is first formed as they do after aging, particularly at low temperature. The writer has studied the increase in viscosity of cream on standing at low temperature (the so-called aging effect), and has concluded that, while the improved consistency of the cream is due to the increase in density of the fat, the increase in whipping quality is due primarily to the increase in hydration which hydrophilic colloids undergo at decreased temperatures.

The cause of the failure of homogenized cream to whip is no doubt due to the fact that the increase in surface area of the fat causes the adsorption of such a large proportion of plasma colloids that there is insufficient of these substances left for the stabilization of the foam. The addition of foam-stabilizing colloids (gums, etc.) is necessary in order to produce a permanent air emulsion.

ICE CREAM.

Ice cream presents an especially large number of unsolved problems of a colloidal nature. These are by no means confined to the protective effects of the various colloidal "binders" and "fillers" against the growth of ice crystals which has been pointed out by Alexander (19) and recently reviewed by Clayton (20). Ice cream manufacturers have begun to appreciate the importance of viscosity of ice cream mixes in relation to "overrun," "body," and texture. The great variety of formulæ now in use commercially in compounding ice cream mixes opens up a wide field for investigation of the fundamental factors involved in giving the mix the desired qualities. It is in reality an open question whether viscosity can be used as a sole measure of these qualities.

A practical problem of great importance which suggests a colloidal solution is that of the crystallization of lactose, giving the product known as "sandy" ice cream. Attempts which have been made in the writer's laboratory and elsewhere (21) to solve this problem by colloidal protection have failed.

BUTTER.

The formation of butter from milk and cream is an outstanding phenomenon in emulsion chemistry. Cream represents an emulsion of the oil-in-water type, while butter is of the opposite, or water-in-oil, type of emulsion. The dispersion of the fat in cream containing 25 to 30 per cent fat is somewhat greater than the dispersion of water in butter, as shown by the following data.

	Range in diameter (millimeter).	Range in number per cubic millimeter.
Fat globules in cream.....	0.010-0.0016	15,000,000-25,000,000
Water drops in butter.....	.047- .0011	3,000,000-13,000,000

The range in number and size of the water drops in butter was first determined by Storch (22).

The character and type of emulsion of the two products, cream and butter, suggest that the fundamental process of churning is one of inversion of emulsions, as first suggested by Fischer and Hooker (23). The writer has followed this process, using the electrical conductivity method of Bhatnagar (24), and finds that the conductivity of cream slowly falls to a minimum during churning, the change beginning at once at the start of the churning. This minimum is reached, however, considerably before the butter "comes." This result has been interpreted to mean that the inversion of phases is gradual, and is completed sometime before the "break," the point of minimum conductivity representing the time when the inversion of phases is completed. The real butter granules are nearly microscopic in size, which accounts for the prolongation of agitation necessary for their coalescence into the larger visible particles at the moment the butter comes.

The results of Clowes (25) on the effect of Ca-Na ratios on the inversions of oil-in-water to water-in-oil emulsions have been tested by the writer on churning, without, however, being able to find that a great excess of Na ions depresses the churning or that an excess of Ca ions favors the process.

Rahn (26) has recently proposed a surface tension theory of churning to explain the destruction of the fat globules so that these may coalesce. The adsorption of hydrophilic colloids at the surface of water-insoluble substances is known to alter profoundly the properties of the adsorbed substance, as pointed out by Robertson (27). This fact may be the cause of the belief in the existence of a special membrane substance around the fat globules in milk.

The constitution of the milk fat has an important influence on the amount of water which will be retained in the water-in-oil emulsion after the inversion of phases. Hunziker and coworkers (28) have shown that an increase in the oleic acid content of the fat increases the water-holding capacity of the butter. This result seems to be a very practical illustration of the work of Harkins (29) and Langmuir (30) on the relation between the orientation of molecules in surface films and the area which fats and glycerides in general can occupy on a surface of water. These investigators have shown that it is the unsaturated fatty acids which cause an increase in the water-covering capacity of a fat.

The physical constitution of butter also plays an important part in the keeping quality of the product. The writer has calculated that the water-fat interface in a pound cake of butter may easily equal 1,000 square meters. This fact should be of considerable importance in connection with the various hydrolytic decompositions to which butter is subject. In a similar way the air which is emulsified with and forms a part of the structure of butter is a factor in deterioration, as Dyer (31) has shown.

CHEESE.

The colloidal problems of cheese are by no means confined to the production of the curd; i. e., the rennin coagulation. The rennin clot is not cheese, but becomes transformed into cheese through the agency of bacterial and enzymatic action. The colloidal problems of Cheddar cheese, for example, are concerned with the transformation of a soft, fragile colloid gel into a more or less tough elastic product, which eventually passes again into a crumbly state as the ripening advances. The changes in structure which underlie this change in property can not be wholly chemical, but undoubtedly are in part colloidal. Little or no study has been given this subject from a colloidal point of view, either in the case of Cheddar or of any of the other numerous kinds of cheese.

CONDENSED MILK.

When milk is evaporated in vacuum until about two-thirds of the water is removed, changes occur which undoubtedly have a profound effect on the equilibrium between the molecularly and colloiddally dispersed substances. That this is particularly true, so far as the sta-

bility of the casein compounds is concerned, is shown by the fact that evaporated milk will at times clot during the sterilization process under conditions which would not affect the fresh milk (32).

This is one of the most important problems in the evaporated-milk industry and is largely colloidal in nature; at least, it is a problem which deals strictly with the stability of a colloidal dispersion.

DRIED MILK.

When milk is dried by the roller process at atmospheric pressure, even the few seconds' contact with the hot drum renders the casein and albumin incapable of redispersion in water. This is not true to so great an extent in the spray processes, whose products retain in large measure their ability to disperse again in water.

The colloidal problems of the dried-milk industry have two general phases. One is to produce a product which retains the colloidal properties of the fresh milk. The other is to prevent deteriorations of the oxidative and hydrolytic types in the finished product.

To produce a dried milk which has undergone no alteration in colloidal constituents, and which retains just the degree of moisture for the maximum ease of wetting and redispersion, and at the same time be dry enough to prevent hydrolytic deterioration, presents some very complex problems in applied colloid chemistry.

So far as keeping quality is concerned the writer believes that oxidation plays a more important rôle than hydrolysis in causing deterioration. This is especially true for whole-milk products. In this connection Palmer and Dahle (33) have shown that the granules of the pressure and centrifugal spray powders possess a central core of air which undoubtedly plays a rôle in causing the tallowy decomposition to which these products are subject. This structure suggests that in these methods a very fine milk foam is actually dried rather than drops of fluid milk. It is also of interest to note that the tension at the air-powder interface is sufficiently great that it is unaffected by the most vigorous grinding in a mortar. Continuous grinding in a ball mill is required to rupture the membrane.

TECHNICAL USES OF MILK PRODUCTS.

For the sake of completeness, mention should be made of the many colloidal problems connected with the use of casein in the arts and industries. The use of casein in the manufacture of glue, paint, and plastics, in many cases involves colloidal phenomena, and the colloidal properties of the product. Practically no study has been made of these products, however, from this point of view.

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SUR LA PRÉSENCE DE LA LÉCITHINE DANS LE LAIT ET DANS LA GLANDE MAMMAIRE.

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Depuis la découverte de la lécithine on a apprécié pour son dosage sa solubilité dans l'alcool-éther et son contenu d'acide phosphorique. On a supposé que le phosphore extrait par éther-alcool des matières végétales ou animales prenait son origine dans la lécithine. Il y a peu de travaux dans lesquels on ait démontré qu'il s'agit vraiment de la lécithine, c'est-à-dire de la combinaison de l'acide glycerophosphorique avec les acides gras saturés et avec le cholin. Dans le lait aussi on a démontré la lécithine non par des procédés scientifiques, mais par le dosage de l'acide phosphorique soluble dans l'alcool-éther. Il y a plusieurs méthodes analytiques bonnes et mauvaises pour le dosage de la lécithine dans le lait. Les meilleurs procédés donnent 0.06 jusqu'à 0.09 pour cent de lécithine dans le lait naturel. On ne s'est jamais occupé de son isolation, ni de sa constitution. Les progrès dans la chimie des phosphatides ont eu pour résultat que Koch et Wood ont différencié dans le lait 0.036 jusqu'à 0.049 pour cent des lécithines et 0.02-0.045 pour cent des céphalines. Les lécithines sont des phosphatides solubles dans l'alcool-éther, qui se précipitent par l'acétone et on peut résoudre le précipité dans l'alcool froid, tandis que les céphalines, qui diffèrent des lécithines par la présence des acides gras non saturés, se dissolvent à l'alcool chaud.

Le lait se forme dans la glande mammaire et c'est pourquoi qu'il serait très intéressant de savoir en quelle quantité les phosphatides s'y trouvent.

J'ai examiné la glande mammaire d'une vache en pleine lactation. On a coupé la glande en petites tranches, qu'on a séchées sur les petits plats de verre dans une étuve à une température qui ne dépassait pas 60° C. On a mélangé la graisse qui est sortie de la glande pendant le séchage avec la matière sèche. Après cela, on a extrait la matière au moyen de l'éther dans un appareil de Soxhlet. La graisse obtenue par l'extraction contenait 0.902 pour cent d'anhydride phosphorique, après le lavage à l'eau chaude 0.608 pour cent. La matière épuisée a été extraite de nouveau par l'alcool (96 pour cent). L'extrait alcoolique contenait 0.417 pour cent d'anhydride phosphorique. On a utilisé l'extrait éthérique de la glande mammaire pour l'analyse fractionnée par Erlandsen. On a mélangé la solution par l'acétone à l'excès, on a recueilli le précipité sur un filtre. Les phosphatides précipités représentent une matière boueuse blanche, jaunâtre. Les précipités ne se dissolvaient pas entière-

ment à l'alcool chaud, il y est resté une substance jaunâtre, que j'ai signifiée sous le chiffre 1. Après le refroidissement de la dissolution alcoolique on a obtenu un précipité blanc, désigné sous le numéro 2 et il est resté dans l'alcool froid une substance marquée sous le chiffre 3. Pendant une semaine, le liquide acétonéthérique a donné encore une partie de précipité qui se dissolvait partiellement dans l'alcool froid (matière no. 4), le reste entrainé à l'état chaud dans dissolution (matière 5).

Le liquide acétonéthérique qui résulte de ce procédé contenait encore une matière phosphorique (substance no. 6).

La substance de chaque fraction a été dosée, les précipités par la filtration et le desséchage sur un filtre pesé, les dissolutions par le dosage de la matière sèche à l'étuve (100° C.). Dans toutes les fractions on a dosé l'acide phosphorique et la table ci-dessous donne les résultats suivants:

TABLE I.—*Les fractions qu'on a dosé à l'acide phosphorique, précipitées par l'acétone et de la solution acétonéthérique.*

Fraction.	Pour cent de la fraction dans la matière sèche de la glande.	Pour cent PO dans la substance de la fraction.	Pour cent PO dans la matière sèche de la glande	Pour cent PO dans le contenu total de l'acide phosphorique de l'extract.
Précipitée par l'acétone:				
1.....	0.28	2.81	0.04	15.0
2.....	.57	7.60	.04	15.0
3.....	1.24	2.26	.02	7.5
4.....	.30	7.80	.02	7.5
5.....	1.47	1.93	.02	7.0
Solution acéton éthérique (la graisse et les matières extractives non précipitables).....	36.65	.38	.13	48.0
Total.....	40.51	.....	.27	100.0

La glande mammaire est plus riche en phosphatides de caractère céphaline qu'en lécithine. La quantité des premières (fraction 3, 5) dans la matière sèche fait presque 3 pour cent. Le contenu de l'acide phosphorique dans la fraction isolée était pourtant plus petit (1.93–2.26 pour cent) que dans les céphalines déjà connues.

La glande mammaire ne contient qu'une petite quantité de phosphatides de caractère lécithine (fraction 2, 4). Nous n'avons démontré que 1 pour cent de la matière sèche. Le contenu de l'acide phosphorique correspond à celui de la lécithine. Nous avons trouvé 7.6, 7.8 et 10.62 pour cent de l'anhydride phosphorique, ce qui fait 3.3–4.6 pour cent de phosphore dans la fraction. D'après Thudichum la lécithine pure, préparée du cerveau, contient 4 pour cent de phosphore.

Presque la moitié (48 pour cent) de l'acide phosphorique de l'extract d'éther n'appartient pas aux phosphatides, mais aux matières qui ne se précipitent pas par l'acétone. Cet acide phosphorique était partiellement lié à la graisse (22.2 pour cent) parce qu'on ne peut pas l'épuiser à l'eau chaude et l'autre partie est soluble dans l'eau (25.9 pour cent) sous forme ou de l'acide glycerophosphorique ou d'autres matières de décomposition. On peut soupçonner que la partie des phosphatides se décomposent pendant le procès d'isolation.

D'après ces observations, il est évident que la glande mammaire est plus riche en matières phosphatées extractives que le lait. Des phosphatides prédominent les matières de caractère céphalines; les substances de caractère lécithines étaient démontrées en quantité beaucoup plus petite.

La richesse des phosphatides dans la glande mammaire (calculés comme lécithine 4.4 pour cent dans la matière sèche) donne à croire que ces phosphatides jouent un grand rôle dans la formation du lait, spécialement de la graisse.

[Abstract.]

ON THE PRESENCE OF LECITHIN IN MILK AND IN THE MAMMARY GLAND.

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The author wishes to draw attention to the study of phosphatids in the mammary gland which probably play an important rôle in the formation of milk and milk fat.

From the observations made, it is evident that the mammary gland is richer in materials of phosphatid nature than the milk. The materials of cephaline character are predominantly phosphatid; substances of lecithin nature are shown to exist in much smaller quantities.

THE VARIATION IN THE MINERAL CONSTITUENTS OF MILK IN DISEASE.

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The writer made experiments on the variation of the mineral constituents of abnormal milk in two instances; one experiment on the milk in a case of acute gastroenteritis and the other on mastitis. He obtained the following results:

In the case of acute gastroenteritis, there were observed in the milk such phenomena as increase in the density of color, much odor, abundant colostrum and lymphatic corpuscles, coagulation by alcohol and heating; and diminution of quantity. These were found to be the conditions frequent in abnormal milk, caused by general diseases, though there were some differences in degree.

The quantity and the composition of the milk responded quickly to the diseased condition, and the variation became more noticeable as debility from lack of nourishment increased. In the case of the diseased milk gland the variation was very evident. The ash content was greater in some cases and less in other cases than is usual in normal milk, but there was no striking difference. The ratio of potassium to sodium, increase of sodium and chlorine, and decrease of calcium and phosphorus were contrary to those of normal milk; but the difference was not very conspicuous except in the case of mastitis. The variation in the quantity of milk and its mineral constituents kept a direct ratio to the condition of the disease.

In the case of mastitis, lactation almost ceased, the milk taking on an abnormal appearance. It became red-brown in color; and as a

result of the coagulation of the proteins, it separated into coagulum, blood, and serum. But as the disease progressed favorably these symptoms gradually disappeared.

The milk showed consistently an alkaline reaction, emanated a bad odor, and tasted salty. There was great variety in the size of the fat globules, and white and red corpuscles were abundantly found. It was also coagulated by adding 68 per cent alcohol and heating, and its acidity as well as specific gravity was greatly lowered.

The fat content was also greatly diminished, and there was only a trace of sugar, which, however, increased to 0.102 per cent or 0.108 per cent when the condition improved. This confirmed the statements of investigators in the past, that the sugar content decreased or increased in accordance with the pathological condition. On the other hand, the albumin content of the abnormal milk showed greater increase in some cases and greater decrease in other cases, in its absolute quantity than in the case of normal milk, but, in the comparative quantity, as against dried quantity, it showed always a marked increase. This was to be attributed to the blood coming into the milk gland and also to the abundant presence of the white corpuscles generated.

As to the mineral constituents, contrary to the case of normal milk, sodium and chlorine showed an increase while calcium and phosphorus showed a decrease, but, as the symptoms abated, the variation was that of normal milk.

ON THE MINERAL CONSTITUENTS OF COLOSTRUM MILK.

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With regard to the research work on the mineral constituents of colostrum milk secreted soon after parturition, we have a few contributions by Eugling, Kruger, Schrodtt, and Trunz, Eugling's results having often been quoted. But his work is old, while the work of the three other investigators is insufficient in quantity, as they made analyses only three or four times at most; in consequence, the difference in the ratio of each constituent found by them was great. According to the results of Eugling and Kruger, alkali salts are present in very small quantities, and the ratio of potassium (K_2O) to sodium (Na_2O) shows 1.1:1—that is, the quantity of each constituent is about the same, while Schrodtt's and Trunz's investigations result in no great difference between them, showing 1.7:1, after parturition, and 2.9:1 (Trunz) in 24 hours after parturition.

The quantity of calcium (CaO), according to Eugling, shows a very high rate, and there is not much difference between the ratios reported by the three other investigators. But, regarding phosphoric acid (P_2O_5) and sulphuric acid (SO_3) the results by Eugling and Kruger are quite different from those of Schrodtt and Trunz. There is also some difference in their statements as to other constituents. For instance, the results of both Schrodtt and Kruger show a small quantity of chlorine; and, according to Eugling, magnesium, a constituent found particularly in colostrum milk, is found in equal quantity in normal milk.

In order to learn more accurately the relationship of these constituents, the writer made 11 tests of colostrum milk, taken just after parturition, and 24 hours later, from six milk cows kept by his university. The results obtained showed that there was a wide difference between the mineral constituents of the milk, depending on species and the individual animal. To obtain more accurate knowledge of the average quantity of each constituent found in cow's milk would require further investigation with a larger number of samples; but, so far as alkali salts, potassium (K_2O), and sodium (Na_2O) were concerned, no great difference in quantity between colostrum milk and normal milk was observed, and the results obtained proved similar to those of Schrodtt and Trunz. However, on his eleventh analysis, the author found one case in which the quantity of potassium (K_2O) and sodium (Na_2O) was very small; their index was also found small, the figures being about the same as those reached by Eugling and Kruger, and the conclusion was that such variation would frequently occur, according to the individual cow.

Furthermore, the author found in some cases the quantity of calcium (CaO), phosphoric acid (P_2O_5), and sulphuric acid, the same as that found by the earlier investigators, and in other cases his figures differed from theirs. But it was proved that these constituents were found in large quantities in colostrum milk.

His chlorine content was not so small as that found by Schrot and Kruger; furthermore, magnesium was found in a larger quantity, especially immediately after parturition, and 24 hours later more alkali salts and less magnesium phosphate were found. Therefore, evidently there was a wide variation between colostrum milk and normal milk.

The writer made investigations on the colostrum milk from three Shropshire and six Southdown sheep, the result of which was as follows:

The color of the milk was yellow or blue-yellow, gradually fading until it assumed the normal milk color in two or three days. The color of the milk of the Shropshire was heavier than that of the Southdown when compared immediately after parturition.

The viscosity of the milk was high, which, however, gradually decreased until it reached the normal state, often on the day following parturition, and in some cases on the fourth day afterward. The loss of viscosity, however, was not proportionate to that of the color.

The milk taken immediately after parturition was of weak acidity or amphoteric and had a stench, but it soon became odorless and no salt was tasted.

It was usually coagulated by heat from three to five days after parturition, but there was no accompanying change in color.

From three to five days after parturition it was also coagulated by alcohol, and this had no relation either to the variation caused by heating or to the change of color.

Colostrum corpuscles could be seen in from seven to ten days after parturition, and fat globules were very large three or four days after parturition.

On the second day after parturition, reaction of oxidase was observed, but it was not so evident as in the case of the colostrum milk of the cow.

The index of each constituent in colostrum milk and its variation was generally the same as in the case of the colostrum milk of other mammals, the only difference being in quantity.

**FREEZING POINT OF COLOSTRUM MILK, NORMAL MILK, AND
END MILK OF LACTATION; AND ITS PRACTICAL VALUE FOR
DETECTION OF WATER ADDED.**

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The writer made experiments on the freezing point of colostrum milk, normal milk, and end milk of lactation, of the following samples:

Sixty-nine samples of colostrum milk taken from 15 cows (8 Holstein, 3 Ayrshire, 4 Guernsey) immediately after parturition and also every morning, from three to seven days after parturition.

Ten samples of end milk of lactation taken from 1 Guernsey and 4 Holstein cows. The milk had a salty taste, loss of acidity at the time of changing color, minute fat globules, coagulated by heating and alcohol, characteristics that distinguish abnormal from normal milk in appearance and odor, chemically as well as microscopically.

Forty-two samples of individual milk taken from Holstein cows, 83 to 382 days after parturition.

Ten samples from 9 Guernsey cows, 19 to 297 days after parturition.

Six samples from 6 Ayrshire cows, 89 to 279 days after parturition.

Two samples from 2 Shorthorn cows, 8 to 38 days after parturition.

Twenty-four samples of mixed milk from 17 or 18 Holstein cows.

Seven samples of mixed milk from 7 or 8 Guernsey cows.

Nine samples of city milk.

The variation in freezing point on the addition of 5 per cent, 10 per cent, and 20 per cent of water was thoroughly tested, the result being as follows:

Freezing point of colostrum milk was: $\Delta = -0.50$ to -0.64 ; average point, $\Delta = -0.567$.

When compared with normal milk, its freezing point was a little lower and its variation was greater. There was, however, some difference according to the individual, but as a general rule after parturition, the freezing point was decidedly lower; and then it went down gradually until it reached the freezing point of normal milk.

Freezing point of the end milk lactation was: $\Delta = -0.53$ to -0.57 ; average point, $\Delta = -0.552$.

There was not much difference when compared with normal milk.

Freezing point of normal milk was: Individual milk, $\Delta = -0.51$ to -0.59 ; mixed milk, $\Delta = -0.53$ to -0.58 ; average point, $\Delta = -0.548$.

As to city milk, when the freezing point of fresh milk free from impurities is below $\Delta = -0.53$, it may be judged that the milk contains some water, as was also found by van der Lean.

When 5 per cent of water is added to the milk, it can be detected by the method of determining the freezing point of the milk with some degree of certainty, and accurately when 10 per cent is added. This method gives better results than various methods often described, but the process requires great care and much skill.

ON THE PRESENCE OF AMYLASE IN MILK AND CHEESE.

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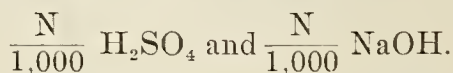
With regard to enzymes, especially amylase, in raw milk, there has been little investigation made, and, methods being inadequate, we know little of the existence and origin of enzymes and their biological activities. On the amylase in cheese, no investigation has yet been made.

The writer, as the first step, attempted to make experiments on the presence and activity of amylase in the water extract of fat-free cheese to see what difference, if any, existed in its effect in liquefying potato and rice starches.

As the materials used for the experiments on amylase have much to do with the results, the writer made a careful selection and used the grade A certified milk, prepared by the Sheffield Farms Co., in New York City, and American Cheddar cheese, specially supplied for the experiment by the same company.

The distilled water used was prepared by the writer, after having distilled it three times with alkaline permanganate solution and phosphoric acid; it was carefully kept in the "Nonsol" bottles, contact with the air being avoided as far as possible. As substrates the writer used five samples of potato starch. These were: Commercial potato starch, washed and purified several times with the distilled water; the starch prepared in the laboratory and washed with 0.3 per cent NaOH; Lintner soluble starch purchased from Merck, which was further purified with distilled water; the soluble starch made by the writer by Brown and Morris' method. The rice starch used was of three kinds: The rice starch prepared in the laboratory; the starch washed with 0.3 per cent NaOH; and the starch prepared by the writer in the same way as the soluble potato starch.

All these were tested for moisture, amylose, acidity, and alkalinity contained and, at the time of the tests, both starch paste and starch solution were prepared in the equivalent quantity to amylose, which were made exactly neutral by using



The amount of the starch decomposed by 10 cubic centimeters of both raw milk and the water extract of fat-free cheese was taken and made equivalent to the quantity decomposed by 100 cubic centimeters of raw milk and 100 grams of cheese.

The result of the above experiment showed that, as regards the existence of amylase in raw milk, the statements of Spontagh,

Zeitscheck, Wohlgemuth, Strich, Koning, Giffhorn, and Lane-Claypon were all confirmed; and, regarding the soluble potato starch decomposed by 100 cubic centimeters of raw milk in 30 minutes, the results were about the same as those of Koning and Giffhorn. The quantity decomposed in 3 hours was found more than that found by Lane-Claypon, and it appeared that amylase was present on all occasions in commercial Cheddar cheese, though its amount varied within considerable limits.

Soluble potato starch was digested more easily than potato and rice starches, by the amylase in both milk and cheese. Rice starch, when compared with potato starch, digested in a shorter time, and assumed a different appearance. In the limited quantity digested in 24 hours rice starch was found in smaller quantities than potato starch. In this connection, an investigation was also made on the pure amylase taken from raw milk and cheese, the result of which was that potato starch was slower in its digestive action than rice starch during a certain length of time; and after that time, the former was quicker in the action than the latter. This afforded a very interesting problem as regards the digestibility of both potato and rice starches by ptyalin in saliva.

Soluble rice starch, as it was found, was less digested than any other starch, but it was uncertain what was responsible for this, and further investigation would be required.

APPARATUS FOR PRODUCTION OF BACTERIAL CULTURES FOR DAIRY PURPOSES.

VICTOR BRUDNY, Dr. Eng., head inspector of the German section of the Agricultural Council for Bohemia, Prague, Czechoslovakia.

The bacteriological laboratories have till now mostly kept secret the procedure for production of bacteria cultures for dairy purposes. The cultures in commerce, particularly the dry cultures, however, are often contaminated, and therefore it is no doubt interesting to become acquainted with a procedure by which reliable bacteria cultures can be produced in each bacteriological laboratory.

In the bacteriological laboratory of the Society of German Dairies and Dairy Farmers, in Bohemia, of which I am manager, bacteria cultures for cream ripening, for production of yogurt and cheese, are made after the following method:

After isolating an original culture of the respective organism from a proper source, in accordance with Koch's plate procedure, this original culture is transferred in the bacteria culture apparatus described by me in the *Centralblatt für Bakteriologie*, Abt. II, Bd. 56, no. 23/24, p. 565. This apparatus is illustrated in the Figures 1, 2, and 3. We see that the lid of a large petri dish is supplied in two places by tubes, of which one is closed up with a cotton plug, the other one by a rubber cap. At the top of the rubber cap there is a glass rod to which is attached a platinum wire. In the lower part of the petri dish there is a circular-shaped frame of nickel plate carrying 12 small tubes, the opening of which is closed below the glass tubes. As soon as the small tubes are filled with liquid media, the lid is put on and the whole apparatus is sterilized

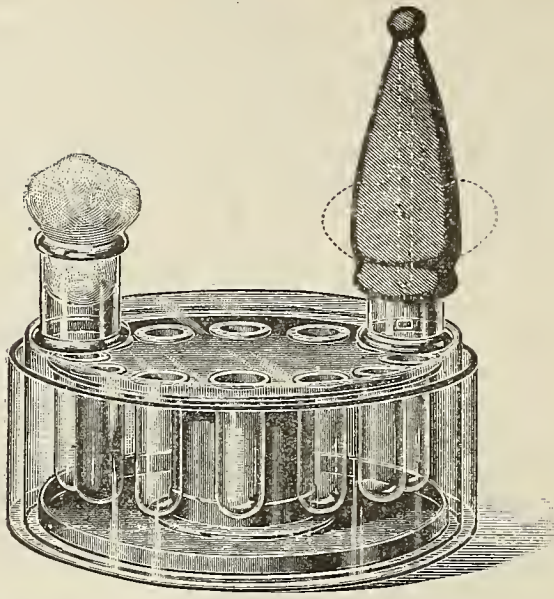


FIG. 1.—Apparatus used in producing pure cultures of bacteria for dairy purposes.

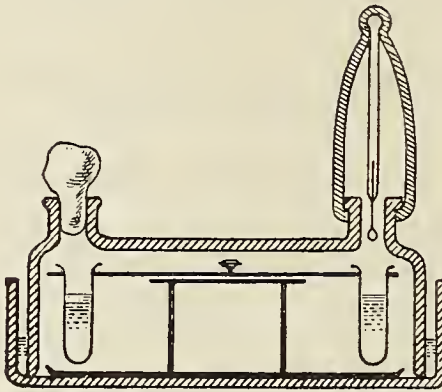


FIG. 2.—Cross section of apparatus.

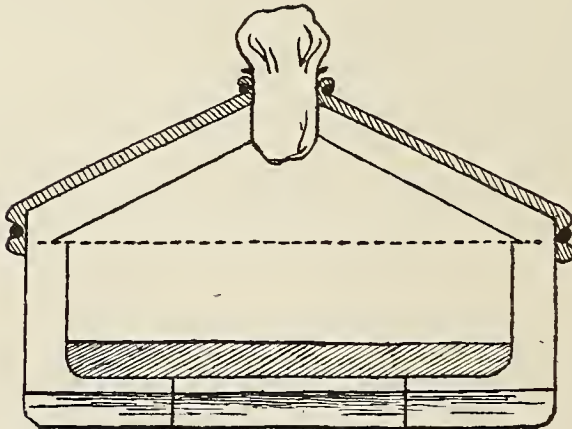


FIG. 3.—Apparatus for producing mass cultures of yeasts and molds.

repeatedly in a current of steam. Then, as in the common petri dishes, a sublimate solution is applied between the lid and the lower dish, and the first small tube is inoculated with a bacteria culture through the opening of the cotton plug.

The apparatus may be placed, as it appears suitable, in either the incubator or the ice chest. The transfer of the material from the inoculated small tube into the next with the sterilized liquid medium is effected by a simple turning of the upper dish so that the tube with the rubber cap will be above the small tube. Then by pressing down the glass rod and introducing it into the tube filled with culture some material is taken out of it; and by a further turning of the upper dish it is brought above the tube to be inoculated and transmitted there by again pressing down the rubber cap.

The apparatus is fitting for production of original cultures of all microorganisms that are used for dairy purposes. The augmentation of these original cultures is effected in the following manner:

Lactic acid bacteria for cream ripening, or for production of yogurt or cheese, are propagated in milk which is subjected in Erlenmeyer flasks in an autoclave or to a holding Pasteurization of 100° C. For this purpose I employ an autoclave with regulated electric heating. Reliable dry cultures can be produced out of curdled milk by dipping a sterilized strip of some wide-meshed fabric (e. g., tulle) into the curdled milk and then drying this strip in the autoclave with the aid of a hot air current. I produce a current of hot sterilized air of any desirable temperature by means of electricity. The strips with the dried lactic acid bacteria are sent in sterilized test tubes or in letters supplied with parchment paper envelopes and are rejuvenated before use like powdered dry cultures.

The production of mass cultures of yeast and molds for dairy purposes requires other apparatus, because these cultures are not ready within a few hours, as is the case with lactic acid bacteria, for those need two or three weeks for their argumentation. As within this time the medium usually dries out, I employ for the production of such mass cultures glass vessels in which the dampness of the air can be regulated. As shown in the illustration (fig. 3), the vessel consists of a large crystallizing dish wherein another smaller one containing the medium is set. At the bottom of the larger bowl—i. e., between the two bowls—there is water. The covering of the larger bowl is made by so-called sheet cotton extended over a funnel-shaped nickel-plated frame. The same reposes upon a wire netting placed above the dish with the medium. The opening of the funnel can be closed with a common cotton plug, and through this plug the medium can be inoculated and the water in the larger bowl replenished. The clumps of mold are floated on sterilized broth and forwarded in sterilized bottles. I am ready to show particulars in my laboratory to interested persons.

SESSION 23. EQUIPMENT: MATERIALS AND STANDARDIZATION.

Honorary chairman, ARTURO PIMENTEL, agricultural engineer, Ministry of Agriculture, Buenos Aires.

Chairman, W. L. CHERRY, general manager, J. G. Cherry Co., Cedar Rapids, Iowa.

Secretary, A. C. BAER, professor of dairying and dairy husbandry, Oklahoma Agricultural and Mechanical College.

Y. M. C. A. ASSEMBLY HALL,
Syracuse, N. Y., Wednesday, October 10, 1923—9.30 a. m.

Chairman CHERRY. Our honorary chairman, Mr. Pimentel, has not yet arrived. If so, I have not been informed. We have rather a long program, and I believe we should begin as quickly as possible. I think there may be more or less discussion of some of the papers.

The first paper this morning is on "The standardization of dairy equipment," by J. G. Stapleton, governing director of Messrs. A. Stapleton and Sons, England. [Applause.]

STANDARDIZATION OF DAIRY EQUIPMENT.

J. GILLARD STAPLETON, governing director of Messrs. A. Stapleton and Sons, Ltd., Enfield, England.

The necessity for standardizing dairy equipment is so urgent to insure efficiency and economy that it is difficult to understand why this subject has not received a larger share of attention in the past. We find that, daily and almost hourly, every dairy firm suffers some inconvenience through the lack of uniformity in the methods, appliances, and utensils which are used in connection with dairy work.

The creamery proprietors and all those responsible for handling the milk should, first of all, determine the standard equipment necessary to secure efficiency and economy, and then insist upon its adoption; and if this were done, producers and manufacturers would have to come into line.

It is admitted that there is no business that is beset with so many difficulties due to the lack of standardization as that of the dairy trade, which deals with a commodity so perishable. At the same time it is most important as a food, and a food which is constantly changing its characteristics from the moment it leaves the cow until it is successfully disposed of, or perhaps becomes a total loss through lack of standard method and equipment.

For these reasons, if for no other, standard equipment is absolutely essential in the dairy, and if we follow the lactic fluid from the moment it leaves the cow until it reaches the glass bottle, we shall discover how far in many countries we are from an ideal system, and how great the need there is for reform in this direction.

Let us first enter the milking room, from which it is estimated that at least 40 per cent of the foreign matter in milk comes; this first contamination is responsible for dangerous and far-reaching consequences. The dirt which falls from the cow's flanks and udder, and often from the hands of the milker, into the open pail contains bacterial spores and bacteria foreign to milk, often dangerous to the consumer. The fresh-drawn milk, which with animal heat, at about 90° F., unremoved, develops bacterial life at an enormous rate. The necessity is urgent to adapt standard equipment in the milking rooms to prevent the contamination of the milk by foreign matter. It is almost useless to remove this foreign matter after it has entered the milk, as the mischief is then done, and the removal of the solid dirt does not remove the contamination.

Here we find the need not for the invention of a standard milking bucket, but rather for its general use, which should in all cases be insisted on. A standard milking bucket is required that will insure the minimum amount of contamination in the milking room. A bucket, to secure this, should be covered with a sterilized straining fabric which should be changed after each milking; but if it is used more than once, thorough washing and sterilizing by steam are necessary, or otherwise contamination of the milk is certain. Another important feature of a bucket, necessary to secure the milk from contamination in the milking room, is a covered lip, protected by a metal flap, over which the milk can be poured when the milk is removed from the bucket.

After the operation of milking, the milk should be transferred as promptly as possible to the cooling room and passed through a recognized standard strainer. The most efficient type of strainer is a combination of two wire-gauze discs with a pad of sterilized cotton wool between, and this cotton wool pad should be used for only one milking.

Much has been said for and against the use of milking machines. Much of the opposition comes from prejudice, which always dies hard, but the greatest opposition is that which has resulted from disappointing experiences by users of imperfect machines. The use of rubber connections and the trouble experienced in keeping them clean, and the fact that the teat caps are likely to fall off, and all sorts of foreign matter are in consequence drawn into the milk receiver, were sufficient to condemn the early makes. All these difficulties have, however, been removed long ago, and a good standard milk machine is now available. So strong has been the influence of the early and imperfect models that we are told that at the present time only one milking machine is known to be in use in Denmark. Our New Zealand friends, on the contrary, are almost unanimous in their praises of the milking machine and declare they could not do without it.

Before passing from the consideration of the equipment of the milking room, it should be borne in mind that, however perfect the equipment selected as standard may be, it is essential to provide efficient steam sterilization of all utensils that come in contact with the milk, if absolute protection from contamination is to be secured.

The one thing, more than another, which needs standardizing in the dairy, is the railway milk churn. Every churn manufacturer

seems to be imbued with the idea that, to make a name for himself and his goods, he must produce something different from his competitors; utility or efficiency are thereby heavily discounted in this attempt to make something which will appeal to the popular taste. The need for an interchangeable standard lid has led to endless trouble and confusion. Many clumsy efforts have been made to remedy this evil. Patent hinges and "bull ring" attachment and similar twin arrangements, whereby each lid is attached to its own churn body, have been introduced to obviate the necessity for interchangeable lids, but all these present difficulties in handling make them objectionable, especially during cleansing operations.

The 17-gallon churn has been the standard churn in England for many years, and was originally known as the eight barn-gallon churn, but its days seem to be numbered, and the American type, holding 10 gallons with dome lid pressed out of one piece, slightly tapering and interchangeable, is likely to be adopted as a standard.

The motor lorry for the collection and delivery of milk has now come to be recognized as an essential part of the equipment of the modern dairy, and here we ought to have a standard type. The 4-ton lorry finds most favor; this is fitted with a platform, 84 inches by 180 inches, which holds 36 seventeen-gallon churns, holding 612 gallons. Fifty-five Danish pattern churns, containing 935 gallons, may be carried on the same lorry. The glass-lined tank lorry has many advocates where its use is possible.

In the matter of cream separators, there is a decided need for a standard pattern. Manufacturers are constantly introducing new designs, most of them with very little to recommend them, and in many instances in no way better than their predecessors. As a matter of fact, makers have repeatedly introduced new features one year, and discarded them the next, in favor of the original designs. The cream inlet has been changed from the side of the bowl to the top, and has gone back again to its original place. One firm has brought out over 30 different patterns. The greatest evil of this everchanging program is the fact that, as the older patterns become obsolete, wearing parts are not stocked, and what is perhaps a sound reliable machine has to be scrapped to satisfy the whims of the makers. Good separators have been discarded and the expense of new machines incurred for no other reason than the fact that spare parts could not be obtained. Again we find that for the purpose of making these machines, hundreds of very expensive gigs, tools, and gauges have to be produced, and the cost of these, as a matter of course, must be charged against the machine.

Coolers we find in England are gradually becoming standardized; the circular cooler, which enjoyed a certain amount of popularity, owing to its being easily cleaned, is being steadily displaced and the tubular type substituted, which has the lower section reserved for brine when brine cooling is necessary.

Pumps are an endless source of trouble in the dairy; the chief objection to them is the difficulty of keeping them clean; they are also the cause of froth and waste. The standard practice should demand the use of elevators instead of pumps, and, wherever possible, gravity should be made to serve the purpose of pumps.

The problem of efficient Pasteurization is one on which most attention is concentrated at the present time. Almost all the advocates of Pasteurization are in favor of the retarding system, but a standard method is yet to be established.

However, so long as the bacterial count conforms to the regulations, the simplest form of apparatus should meet with general approval, and there should be no difficulty in finally fixing upon a standard in this direction. No standard equipment for retardation should, however, be accepted by the trade unless it provides positive retardation without the possibility of recontamination after the milk has been retarded; this can be secured only by an equipment that provides for retardation in the bottle under an air-tight cap.

The refrigerating machine is indispensable in every dairy, and we find that, although these machines generally work on the same principle, combining a compressor, condenser, and evaporator, three refrigerating gases are commonly used, ammonia probably being the most suitable for dairy work. Each of these gases has its own patrons, and they are equally efficient if properly applied. It is the standard of work they are capable of performing which concerns us most.

The buying of milk by measure, instead of by weight, is the usual practice in England, and here reform and a standard method are most urgent. At many English dairies, milk is accepted on the scale of measurements recorded on the railway churns. In the first place, however, these measurements are very often inaccurate, and in any case the system is not strictly legal, as these churns are not stamped measures. A dent in a churn may make a difference of a pound. If the churns rest on an uneven surface when reading off the quantity it may differ by a pint or two. Then the shrinkage of milk which may have been dispatched from the farm when warm and frothy, often leads to disputes which do not tend to strengthen friendly relations between buyer and seller. A standard weighing machine would obviate all disputes in this direction. In America, Denmark, Ireland, and other countries, the system of buying by weight has been invariably adopted.

The bottling of milk in all forms, whether sterilized, Pasteurized, or raw, will possibly be universally adopted in England at no distant date; although bottle-filling machines have been vastly improved of recent years, there is still room for the inventor to exercise his ingenuity in this direction and secure the acceptance of a standard type. Rapid filling, without waste, and exact measurement are the ideals to be aimed at. The rush of air from the bottles, caused by the inflowing milk, and the foam caused by the agitation of the milk, are troubles which must be avoided, and the leakage between the filling of each bottle must be prevented, as such leakage involves contamination of the milk.

In the matter of accounts there is little uniformity. We find that dairy firms who have not been trading long invariably adopt a system of bookkeeping of their own. Some of these may be excellent, others the reverse, and the auditors who have to wade through the books are often deserving of sympathy; we find that the lack of standard methods is the cause of loss of time and efficiency.

When looking for faults in dairy equipment, and seeking to rectify them, it would be wise if manufacturing firms would heed the suggestions of the attendants in charge, as they have special opportunities for noticing defects and tracing their causes. Although machines are made by skilled mechanics, in many instances they never see the machines they make in actual and continuous work. All parts may be machined and gauged with the greatest accuracy, gears cut true to the thousandth part of an inch, and the assembled machine subjected to a rigorous inspection; yet there may be something faulty in the design, which reduces its efficiency, but which can never be discovered except during actual work.

Chairman CHERRY. Are there any questions to be asked of Mr. Stapleton, or any discussion on this paper? If not, we will pass on to the next paper. Is Mr. Van Kuren here? He apparently is not here, so we will take up the third paper, "Benefits of the principle of standardization," which will be read by Mr. Hudson, special agent of the Division of Simplified Practice, United States Department of Commerce. [Applause.]

Mr. HUDSON. The previous speaker has told you of the necessity for standardization in the dairy industry. My paper will deal more perhaps with the benefits of standardization. I will show several examples of advantages that have been obtained in other industries where standardization is being applied. The old saying that "the proof of the pudding is in the eating," applies very well in such a discussion.

BENEFITS OF THE PRINCIPLE OF STANDARDIZATION.

RAY M. HUDSON, technical assistant, Division of Simplified Practice, United States Department of Commerce.

High cost of production, high cost of distribution, and high cost of living, are the most formidable trio of economic problems that we, as a nation, have ever been called on to solve. And solve them we must, for on their solution depends not only the peace and prosperity of these United States, but also the maintenance of amicable relations with and in other countries, on whom we are dependent for those foreign raw materials and finished products required by the American standard of living.

The causes for these greatly increased costs are fairly obvious, and no detailed explanation of them is needed here. Suffice it to say that the rapid growth in world population, the steady inroads into natural resources, and the advancing standard of world living have intensified demand for goods and services far beyond existing capacity to supply them. Added to the increasing difficulty of supplying world wants, are all the upsets and disturbed relations because of and arising out of the great war. The sum total of all these conditions, and their incidence on the affairs of men, have made economy, thrift, and conservation the watchwords of nearly every nation. It has been demonstrated, in many instances, that the application of the principle of standardization brings practical, tan-

gible, and definite results in lowering costs, whether they be of production, distribution, or consumption.

"Standardization," however, is a much overworked word. Unfortunately it has come to have a connotation that implies solidifying everything from products to processes at their present stages of development, and thereby stopping all further research, invention, science, and progress. Standardization, per se, is not static; it is dynamic.

It is the continuous process of crystallizing the best thought and practice of the industry or the art, and coincidentally eliminating that of proved lesser quality, utility, or value, as uneconomic, wasteful, and destructive effort; it is the measure of progress, and the incentive to further advancement. For no sooner has any one thing reached a certain degree of development than effort is concentrated on and applied to the problems of refining, improving, and further developing that thing to higher limits of performance, utility, and satisfaction.

Standardization may begin at any point in the circle of commerce. In some cases efforts have been successfully directed to some specific feature of the article, or phase of the process under consideration, without regard to the other existing variants. In other cases the primary effort has centered on the elimination of superfluous and unnecessary existing varieties in a common field of endeavor to the end that all such extraneous matters may be disposed of preparatory to intensive concentration on the varieties remaining. No matter which course is first chosen, the ultimate result is the same, for, just as proved and demonstrable refinement causes the elimination of the unfit, so does such elimination induce improvement and advancement in those that survive.

As to the relative economy in the two approaches perhaps the elimination of superfluous and nonessential is more logically the primary process. At least that approach offers the best promise of early return on the effort made, whereas standardization, being at best a rather slow process of eradication, involves a much longer time interval before its benefits will be apparent. This primary process, this shorter and easier way to economic stability, and consequent prosperity, is called "Simplification," meaning to reduce, to eliminate, to eradicate, or to simplify.

Simplification is now being widely adopted, not only as a fundamental business policy by numerous individual plants or enterprises, but also by many entire industries through the cooperation made possible by trade associations among their members. When, under Herbert Hoover (now Secretary of Commerce), the Committee on the Elimination of Waste in Industry completed its survey of waste in six major industries of the country that group of 18 leading industrial engineers reported an average waste in these fields of human endeavor amounting to 40 per cent, and supported their conclusions by a most adequate array of facts.

American industry, which had come to regard itself as rather highly efficient, was severely shocked, and properly so. The report demonstrated that much of the effort in the past had been applied to material improvement, and mechanistic refinement, and that opportunities for relatively greater advancement through better man-

agement, more scientific adjustment of personnel relations, accident prevention, health maintenance, standardization, and simplification were being only casually considered, if not completely ignored in many cases.

For example, it was pointed out that the standardization of newspaper columns to one size would make possible an annual saving of \$3,000,000 to \$5,000,000 on composition and plates alone; and that a standardization of the thickness of certain walls might mean a saving of some \$600 in the cost of the average house. The establishment of correct standards for a fair day's work in many of the building trades would make possible the adoption of methods of payment which would bring higher wages to the workers, at the same time lowering costs to the contractor, and also lessening the cost of construction for the owner or builder. In the men's ready-made clothing industry it was shown that the second fundamental cause of waste attributable to management was the lack of standardization of appliances, conditions, work content of operations, and methods.

Referring again to the printing industry, as illustrative of what may be accomplished in standardization of equipment, there is the standardization of type bodies. Prior to the year 1885, each type foundry cast its type on a more or less different body, and although the exchange from the old system to the "point" system involved an expenditure of some \$3,000,000 by the type founders, it is universally conceded that this expenditure has been saved many times over. As a consequence of these, and similar findings in this one industry, seven national trade organizations, representing 95 per cent of the consumers of paper, and over 11,000 of the leading firms in their lines, including printers, stationers, lithographers, engravers, advertisers, and purchasing agents, have passed resolutions calling attention to the waste in industry, and urging cooperation in eliminating unnecessary grades, weights, and sizes, and reducing the number of colors, finishes, watermarks, etc.

Managers everywhere are urged to apply standardization as an effective means to eliminate waste. Products should be standardized to the fewest practicable kinds, sizes, and grades. The details of equipment, including machines and tools, should be standardized so as to permit the widest interchangeability, and maximum usefulness, consistent with improvements in design and invention.

Performance standards should be developed as a valuable aid to production planning and control. By constantly comparing actual performance with the standards, and promptly investigating the causes of departure from standard, the manufacturer can quickly detect adverse conditions as they creep in, and can rectify them. Performance standards, in fact, will enable him to plan the size of his plant and operating force for a given volume of business for continuous operation. In the last analysis such standards are the basis for settling the age-old question of "a fair day's work for a fair day's pay." Obviously, performance standards can not be intelligently nor accurately set until the conditions under which the service is to be rendered have been standardized. That means standardization of appliances, conditions, operations, and methods prior to performance measurement and rating.

Dairymen may well be interested in the benefits of standardization, for they are producers, distributors, and consumers. As producers,

they have much in common with manufacturers, for they must develop, build, maintain, and operate "plants," and all that involves material, labor, and machinery. It is mainly through mass-production methods that costs have been brought down in other industrial enterprises, and only through applying standardization at every point in the process is the maximum of production possible from any given plant or establishment.

As distributors, dairymen the world over should be interested in lowering the cost of distribution. The Joint Commission of Agricultural Inquiry, in its recent masterful analysis of the agricultural crisis in the United States, urges the agricultural producer to standardize the production of crops in various producing centers, so as to permit more economic selection, grading, and preparation of commodities in the producer's local markets. It is further shown that new economies can be brought about through the development of greater uniformity of products, grades, standards, and containers, together with an improvement in methods of handling by agencies in local, primary, and terminal markets, which, combined, will tend to create greater certainty in the receiver and the producer as to the salability of the products.

As consumers, dairymen are affected in the cost to them of nearly everything they buy, due to the huge wastes resulting from lack of greater standardization in materials, products, and processes. The losses in any business are distributed over the income-producing lines. Consequently, if these losses be reduced to the minimum, the invisible tax which every consumer now pays in the price of his purchase, will be lessened.

Transportation costs also form an appreciable item in the selling prices of all commodities, and as a means of reducing those costs the commission recommended the complete standardization, as rapidly as possible, of all freight equipment, except with respect to cubical and weight-carrying capacity, to—

- (a) Reduce the initial cost.
- (b) Reduce the number of necessary repair parts.
- (c) Facilitate the repair of cars and the movement of trains.
- (d) Make possible economies in maintenance of freight equipment.
- (e) Reduce empty-car mileage on bad-order cars.

Standardization is not a panacea for all the economic ills that beset a group, a state, or a nation. It is an effective method for achieving certain specific results, which, in themselves, are essential to the successful stabilization of business. A nation is no more prosperous than its people; if the people prosper, then the nation prospers. Consequently, both the reports mentioned are unanimous in their views that governmental agencies should cooperate with producers, trade and labor organizations, and with each other, to secure more accurate and current statistical data of production, prices, movement, and consumption of commodities, and to promote standardization of product and service, as well as the knowledge of improved method and practice, and more effective relationship between the various agencies engaged in production, manufacture, and distribution.

The United States Department of Agriculture is cooperating with various groups in the broader application of the principle of

standardization in agricultural production and distribution. Also, the United States Department of Commerce is cooperating with organizations of manufacturers, of wholesalers, retailers, and of consumers in the elimination of waste in commodity production and sale, through standardization. The Bureau of Standards in the Department of Commerce is very active in this field, particularly its Division of Simplified Practice. Nearly 100 trade associations are working with the division in a general movement to reduce varieties in commonly used articles, including lumber, containers of all kinds, hardware, automobile parts, accessories and equipment, building materials, plumbing supplies, and several other lines.

Frequently a manufacturer, or group of manufacturers, would like to eliminate excess varieties, but feels that the producers can not properly approach either the distributors or the users of these articles with such a proposal. In other lines it is the distributors who would like to bring about reduction of variety if they could persuade manufacturers and users to agree, while in still other lines it is the user who would most appreciate fewer kinds.

Secretary Hoover has established the Division of Simplified Practice to serve as a centralizing agency in bringing producers, distributors, and users together, and to support the recommendations of these interests when they shall mutually agree upon simplifications of benefit to all concerned. Any group in any branch, production, distribution, or use, can secure the services of the division upon request.

The standardization of equipment committee, organized at the international convention, in October, 1920, has seen its work bear fruit in the cooperative measures, now under way, for the reduction in variety of sizes and dimensions of sanitary pipe and fittings used in creameries, and also in the simplification of milk-bottle sizes and caps.

The division is concerned solely with finding and supporting the best thought and practice of the interested industry. In no way does it make pretense of technical knowledge. In no way does it attempt to determine, or even suggest, simplifications which the industry should adopt. Its sole function is to bring together all interests and to support such action as these interests may mutually agree upon.

The result of such cooperation as above outlined is to promote economy in manufacture, and to stabilize production, thereby saving for the Nation that which would otherwise be a social waste, profitable neither to manufacturer nor to consumer.

Standards in articles of commerce reduce the enormous cost of taking commodities from the manufacturer to consumer, as follows:

By promoting easy and complete understanding between buyer and seller as to dimensions, weight, quality, and performance of the commodities in question.

By reducing the waste accruing from the manufacture and distribution of goods of inferior or unusable quality.

By reducing the waste in accounting, storage, packing, etc., of unnecessary variety of sizes, weights, qualities, etc.

By reducing the legal costs necessitated by lack of common understanding.

Widely accepted standards mean a reduction of human thought and effort required in supplying the most common human wants, thus releasing a large sum total of human thought and energy toward the development of new arts and sciences, social betterment, and the improvement of standards generally.

Chairman CHERRY. I am sure you will all agree that Mr. Hudson's paper was very interesting and very instructive. It should supply an object lesson for those of us in the industry.

Mr. Van Kuren is now present and will present his paper on "Standardization."

Mr. VAN KUREN. In view of the very able presentation of the subject by Mr. Hudson, and in view of the fact that the points brought out in the paper I have prepared are in a large measure entirely covered by him, and in a much better way, I believe it would be an imposition on the time of those present to attempt to introduce this paper of mine at this time. I think the ground has been very thoroughly covered.

Chairman CHERRY. What is the pleasure of the meeting? I will take it for granted, Mr. Van Kuren, that it is satisfactory to the audience to pass this paper. We thank you very much for the effort you have put forth in preparing it. It will appear in the published proceedings.

Mr. VAN KUREN. I might emphasize a point that was brought out in the study of conditions in the dairy machinery industry. We found on investigating our own manufacture that in one type of machine which we are prepared to build at the present time, there were something over 20,000 types, styles, and sizes, no two of which are absolutely identical. In other words, we could build over 20,000 machine which we are prepared to build at the present time, there minute particular. There would be some feature in each one that would differentiate it from all the others. I will just add that to the splendid illustrations which have been given by Mr. Hudson.

Mr. W. H. FORESTER (Hamilton, Ont.). I just have a little item to add to the previous speaker's address, which might be of interest to the dairymen present. That is pertaining to the question of sanitary fittings which he presented to you and he showed you that there were some 10 types, all different. I have been chairman of the International Milk Dealers' Standardization Committee for the past two years, and we have been working on the question of standardization in sanitary fittings. I am pleased to say that at the present time we have arrived at the conclusion of the work and have agreed on one interchangeable sanitary fitting. It is on the table of the assembly room in the Onondaga Hotel; and if any of you care to you may inspect it.

Chairman CHERRY. Is there any other discussion? If not, we will go on to the next paper, "The selection of metals in the construction of dairy equipment," by Mr. O. F. Hunziker, manager of the manufacturing department and director of the research laboratories, Blue Valley Creamery Co. [Applause.]

SELECTION OF METALS IN THE CONSTRUCTION OF DAIRY EQUIPMENT.

OTTO F. HUNZIKER, manager, manufacturing department, and director, research laboratories, Blue Valley Creamery Co., Chicago, Ill.

INTRODUCTION.

With the rapid development of the dairy business, involving larger production and increased consumption of the product of the dairy cow, there has come, automatically, greater centralization of the handling of milk and the manufacture of the divers milk products.

This centralization, in turn, has demanded larger equipment and equipment mechanically more complete and more efficient, in order to make possible more economical manufacture and the use of methods and processes that modern science has shown to be necessary, both for the protection of the health of the consumer and to insure keeping quality of the finished product.

The design and construction of new, larger, and mechanically more complete equipment to meet this demand involved the consideration of metals and alloys and combinations of metals not heretofore employed in milk work, and the effect of which on milk and milk products was largely unknown.

It is therefore not surprising that efforts to take advantage of metals of superior mechanical properties resulted in some instances in the employment of metals and metallic alloys that proved disappointing from the standpoint of their action on the milk, a standpoint but little appreciated in the earlier stages of the operation of milk products plants.

The discussion in this brief treatise will be confined to the consideration of the behavior of some of the metals now used in the construction of equipment for milk products plants and their effect on the quality of the dairy product.

EXPERIMENTAL DATA AND PRACTICAL EXPERIENCES.

The sum total of accurate and scientifically proved information on the suitability of different metals and metallic alloys for dairy equipment, from the standpoint of their effect on the dairy product, is somewhat limited. Experimental data are fragmentary, and much of the knowledge derived from commercial experience bears further investigation. Nevertheless, there is available very considerable specific information on some phases of this subject that is of value, and the wider dissemination of which promises to be of assistance to the manufacturer and user of dairy equipment.

Golding and Feilman (1) found that milk that was run over a copper cooler from which much of the tin had worn off was rejected by the trade because it contained a disagreeable, mealy flavor, and that the installation of a new, well-tinned cooler prevented further complaints. They further report that their investigation showed that exposure of milk to copper, in the presence of air, greatly intensified the metallic flavor, and that the peculiar offensive flavor developed in from 12 to 18 hours after exposure of the milk. They concluded that the presence of copper is antagonistic to lactic fer-

mentation and accelerates the growth of certain undesirable species of bacteria.

Rogers, Berg, Potteiger, and Davis (2) report that, "The addition of even minute quantities of metal salts, as the salts of copper or iron, have a marked accelerating action on the rate of deterioration of butter. Butter made from ripened cream, to which traces of iron or copper have been added, invariably acquired, in a short time, an oily, metallic, or fishy flavor." They state that their results have not indicated that the metal salts have any part in determining the nature of the flavor developed, but their action seems to be wholly an accelerating one, and that the action of copper is more intense in this respect than that of iron.

The Sheffield Farms Co. (3) conducted an extensive investigation in an effort "to determine the origin of a certain bad or metallic flavor" in the milk of their Pasteurizing plant at Pawling, N. Y. In these experiments it was found that copper, copper alloys, and zinc invariably produced a bad flavor in milk, while nickel and tin had no effect on the milk. Their investigators concluded that milk corrodes and dissolves detectible quantities of copper, zinc, and copper alloys at the temperature of Pasteurization; that copper salts give milk an unpleasant taste, apparently identical with that occurring in the bad milk above referred to; that this taste may be either that of the copper salts themselves or may be due to their effect upon bacterial changes in the milk, and that, for these reasons, it is a part of safety to reduce the amount of copper in the apparatus to a minimum, or to avoid it altogether.

Hunziker and Hosman (4) demonstrated that iron and copper, their lactates and their hydrates, and the hydrates of German silver and of brass, when in contact with butter, developed a disagreeable, tallowy flavor in butter and accelerated the bleaching of the butter, while tin and nickel, under the same conditions, had no action on the butter. The tallowy flavor was entirely different from the metallic taste of the metallic salts, the salts of iron, copper, German silver, and of brass, which were used in the experiment. This work, similar to that of Rogers, indicates that these metals and their salts did not determine the nature of the flavor, but their presence induced or accelerated the deterioration of the butter. These investigators concluded that oxidation caused the tallowy flavor, and that the presence in butter of such metals and alloys as oxygen carriers or catalyzers accelerated the development of the tallowy butter.

Hunziker (5) further showed that the use of a poorly tinned surface coil cooler, over which the hot Pasteurized cream was flowing, exposed to air and light, invariably yielded butter that would develop a metallic, oily, or fishy flavor, and he concluded that the action of the copper on the hot cream, exposed in a thin film to air and light, was greatly intensified. In commercial operation, a German-silver coil in a vat regularly produced metallic flavor in the cream and had to be removed and replaced by a tinned copper coil in order to stop the defect. Furthermore, butter, adhering to and remaining even for but a fraction of an hour on the metal parts (piano wire) of printing equipment, will invariably turn metallic and fishy. In the manufacture of condensed milk (6), he observed that the metallic flavor often found in sweetened condensed milk was

due to the formation of copper oxide in the dome of the pan, and when the copper, both in the pan and in its dome, was kept clean, bright, and shining, the product was practically free from metallic taste.

Burrell (7) reports the experience of two farms, where German silver damaged the flavor of the milk. Both of these farms produced milk of the grade of certified milk. On both farms machine milking was done, and the milk pails used had bottoms of drawn German silver and sides of drawn steel, tinned. On both farms the milk was normal when drawn, but developed a disagreeable flavor, called barny in one case and metallic in the other. This off-flavor appeared in from 22 to 36 hours. Investigation showed that this trouble came from the German-silver bottoms of the pails. When their use was abandoned and pails of drawn steel, tinned, were used, there was no more disagreeable flavor in the milk. The German-silver bottoms in the new pails were tinned, and when used subsequently they gave no further trouble.

Additional tests made by Burrell on his own farm, in which he used pails with untinned German-silver bottoms and pails of all tinned steel, confirmed his previous results and conclusions. In all cases, all samples from the pails with the German-silver bottoms developed metallic flavor, while none of the samples from tinned steel contained the metallic flavor. Later tests showed that solid German-silver pails proved as objectionable as pails with German-silver bottoms, while pails of solid nickel and pails of solid aluminum had no effect on the milk.

Cornell (8) reports experiences of large milk-powder factories with German-silver sanitary pipes and fittings. These installations had all to be taken out and replaced by tinned copper tubing, because the German-silver pipes corroded severely, and contributed a distinct metallic flavor to the powdered milk, especially at certain times. In another instance, a market milk plant used a German-silver cooler. This cooler pitted very badly, the surface showing innumerable little holes.

Monel metal, used for lining buttermilk culture machines in a large eastern market milk plant, became considerably pitted and developed a distinct metallic flavor in the product. This metallic flavor was not always noticeable, but only at particular seasons, and when a condition existed that seemed to stimulate electrolysis. Other equipment of the same metal, installed in a milk-powder factory, caused serious damage to the flavor of milk powder, and its use had to be discontinued. The same factory also tried out milk metal with similarly unsatisfactory results.

Supplee and Bellis (9) found that the copper content of milk may be measurably increased by heating or storing milk in the presence of metallic copper, or running the milk through poorly tinned copper pipes; and especially from brass and bronze fittings as the result of the formation of copper compounds due to neglect of sanitary care.

Supplee (10) further reports that even small traces of copper are very detrimental to the keeping quality of milk powder containing fat, and that the amounts of copper, which may be normally taken up from factory equipment by milk stored or heated in its presence, are sufficient to cause premature deterioration.

Donauer (11) studied the taste of different metallic lactates and the relative dilutions at which these compounds can be readily detected in distilled water and in milk. These tests showed that the lactates of copper and copper alloys, such as bronze, white metal, and German silver, were most intense in the power to impart metallic flavor per unit of lactate; aluminum and monel metal ranked next, while nickel, iron, zinc, and tin ranked last, in the order named.

Extensive experiments by Rice and Miscall (12) show conclusively that the presence of air and oxygen increases enormously the amount of copper dissolved in milk. They further found that copper, corroded with an oxide, yields much more of the metal to the milk than smooth, bright copper. Carbon dioxide, on the other hand, did not influence the dissolving power of milk.

Donauer (13) found no difference in the amount of lactic acid produced in milk samples to which had been added different amounts of copper lactate, thereby indicating that the copper lactate had no noticeable effect on the development of lactic acid bacteria, but the filtered and washed precipitate from samples to which enough copper lactate had been added to coagulate the casein, when added to fresh milk, gave early evidence of putrefaction.

Hess (14) and Hess and Unger (15) discovered that contamination of milk with copper, resulting from Pasteurization at 145° F. for 30 minutes in a copper container, diminished the activity of the antiscorbutic vitamin to a far greater extent than milk heated in a glass container. Hess (16) further found that this vitamin also suffered in milk containing 2.5 milligrams of copper lactate per 100 cubic centimeters when the milk was dried by the Just process (roller process). Experiments regarding the copper content of milk and its excretion by infants indicate that copper may enter the physiological processes of the body, which suggests the possibility that its excessive presence in milk may have pathological significance.

DISCUSSION OF METALLIC REACTIONS ON MILK AND MILK PRODUCTS.

The foregoing experimental data, practical experiences, and additional observations which the limitation of space here does not permit of enumeration, make it evident that many of the metals and metallic alloys, now in use in dairy equipment, may and do have a harmful effect on milk and its products. The occurrence and extent of the damage are determined largely by the type of equipment and the conditions of operation. The exact reaction that produces this injury to quality of the dairy product again may vary with the character of the metal itself, the type of equipment, and the conditions of operation. The character of the resulting defect in the dairy product in turn is largely controlled by the nature of the reaction induced by the metal.

Thus, it has been shown that, in some instances, the detrimental effect consists of a distinct metallic flavor which appears in the dairy product immediately, while, in other cases, metallic or other objectionable flavors develop with age, and the deterioration of the dairy product is greatly accelerated. In the first instance, the immediate appearance of a metallic flavor is manifestly due to the presence of

metallic salts which, themselves, have a metallic taste. In this case, the extent of the damage is controlled by the solubility of the metal in the lactic acid of the milk product, and the conditions that influence this solubility, and by the intensity of the metallic taste of the lactate formed. In the second instance, the progressive deterioration appears to be attributable to more complex reactions, of which oxidation, catalysis, and selective influence on bacterial activities are the most probable ones.

RELATION OF SOLUBILITY TO METALLIC FLAVOR IN DAIRY PRODUCTS.

It is well known that metallic lactates have a metallic flavor, and it has been shown that the intensity of the metallic flavor varies considerably with the lactates of the different metals, it being greatest in the lactates of copper and copper alloys, such as German silver, brass, bronze, monel metal, white metal, etc., and least in the case of nickel, iron, zinc, and tin.

Solubility tests, in which the solvent action of lactic acid solutions on the simple metals and on metallic alloys was determined, showed that all metals and alloys are more or less soluble and do form metallic lactates. These tests, however, indicate that copper and the above-mentioned copper alloys have a relatively high resistance to solutions containing lactic acid, nickel and tin ranking next, and aluminum, iron, and zinc showing the least resistance.

These facts are significant, as they not only show relative solubility of the metals in lactic acid, but that these lactates are capable of conveying a bitter, metallic taste to the dairy product, and that the intensity of this taste per unit lactate is greatest in the case of copper and copper compounds. Yet these laboratory solubility tests are somewhat limited in their application as, in commercial dairy operation, the reactions are not limited to the simple action of lactic acid on the pure metal, but are complicated and intensified by diverse other factors.

CORROSION BY COMBINED ACTION OF ACID AND AIR.

More complicated corrosion occurs by the combined influence of a liquid, such as milk or cream, and the atmosphere. This is a common occurrence, but it has so far been given scant attention by manufacturers and users of dairy equipment. Maximum corrosion occurs at the surface of the liquid, or when the metal is alternately immersed in liquid and exposed to air. This action is further intensified when the exposure occurs in the presence of heat and light, and when the liquid is of distinct acid reaction.

It is for this reason, for example, that the use of open-surface coil coolers of copper, or copper alloys and similar equipment, becomes particularly dangerous and objectionable. The milk or cream, when at Pasteurizing heat, flows in a thin film, exposed to air and light, over the copper surface. The action on the copper here is intense, and the resulting product is almost sure to absorb a metallic taste. In the case of cream for butter making, the acidity of the cream further augments the danger. Unless the metal coming in contact with the milk or cream be other than iron, copper, or copper alloys, or be

completely and heavily coated with tin, damage to the flavor of the dairy product is practically unavoidable.

CORROSION BY ELECTROLYTIC ACTION.

The tendency to metallic corrosion in dairy equipment is accelerated by electrolytic action. Most dairy equipment, such as heaters, coolers, ripening vats, pipe lines, etc., involves the presence of more than one metal. The mechanical and wearing parts demand a metal of different structural nature than is most suitable for the stationary parts. There are bronze bearings, bronze or brass fittings and valves, bronze pump linings, etc., copper linings for vats, copper coils, etc. Most of the metals and alloys used differ from one another in their electrical potentials, and they are immersed, in contact with one another, in a conducting fluid, the milk or cream. This combination represents a galvanic battery, the milk or cream constituting the electrolyte.

Electrolytic action in milk work, by the use of equipment of these metals, is therefore not only very probable, but it is practically unavoidable. And the larger the assortment of metals used the wider the difference in their potentials; and the higher the acidity of the milk product the greater must of necessity be the tendency toward electrochemical corrosion and serious damage to the finished dairy product.

The ready pitting and generally unfavorable action of most of the alloys used in dairy equipment, in all probability, largely lie in the fact that their complex nature is more conducive to electrolysis than the simple metals.

Alloys, such as German silver, white metal, monel metal, etc., while generally considered homogeneous in structure, are subject to liquation or segregation of one or more of the metals of which they are composed, especially during the cooling process of the heated, molten mass. If not homogeneous in structure, therefore, it follows that the same electrolytic action will take place in a single alloy as between two metals in contact. The presence of impurities in the alloy, such as dross, slag, or oxides, would also produce the same effect.

EFFECT OF METALS AS OXIDIZERS AND CATALYZERS.

The citations of experimental results and commercial experiences showed that, because of the presence in dairy products of metals, such as iron, copper, or copper alloys, or salts of these metals, spoilage is accelerated; that is, the dairy product develops objectionable flavors far more rapidly than when these metals are absent. This fact prevails even when the metal is present in amounts so small that a metallic taste is not noticeable in the fresh product.

Little is definitely known of the nature of the reaction that causes this deterioration in the presence of metals. Certain indications, however, suggest oxidation, catalysis, or selective bacterial action, or a combination of two or more of these agencies as the possible cause.

Oxidation.—Certain metals are known as oxygen carriers. They have the property of readily taking up oxygen to form oxides, and

then surrendering this oxygen to substances with which they come in contact and which have a greater affinity for oxygen, thereby inducing or accelerating oxidation in these substances. Copper is an outstanding example as an oxygen carrier. Iron also belongs to this class, and it is not improbable that copper alloys have this property. Since the deterioration of butter in storage, for instance, has been found closely associated with progressive oxidation of one or more of its ingredients, it is conceivable that the deterioration caused by oxidation may be accelerated, if not induced, by the presence in the product of metals that are oxygen carriers.

Catalysis.—To what extent catalysis plays a rôle in the deteriorating effect on dairy products is not definitely known. The base metals that are in use in dairy equipment are all capable of catalytic action. The active amount of catalytic substances is often very much smaller than anything we can detect by the ordinary means of analysis, and it has been conclusively demonstrated that the presence of copper, even in exceedingly small amounts, is capable of accelerating spoilage of the dairy product.

As in the case of liquids that have a dissolving action on metals and similar inorganic substances, so does the quantitative effect of catalytic substances on the chemical reaction become accelerated in the presence of oxygen, or with an increase in temperature, etc. And, as Ostwald (17) suggests, while catalyzers are defined as substances that help along chemical reactions without their being altered themselves, their activity may be a transient one. They may be formed in unchanged amount from the products of reaction in case they do react with any of the substances present. They may, for example, be constituents of intermediate products of reaction, and as the process goes on, these intermediate products are broken up, setting the original substance free.

The versatility and complexity of catalytic properties and reactions are pregnant with suggestions that they may play an important part in the deterioration of dairy products that has been shown to result from contact with certain metals, such as iron, copper, and copper alloys.

Selective bacterial action.—But little is known of the effect of metals, their salts, or their oxides on bacterial action, and the scant information on record is somewhat contradictory. In some instances, experimental results appear to indicate that the presence of copper had a retarding effect on lactic acid fermentation and accelerated the activity of putrefactive organisms, while in others the effect of the presence of metallic lactates on the development of lactic acid appeared to be negative.

Nor do these data show whether this selective influence on bacteria, retarding or inhibiting the activity of some species and accelerating the action of others, was due simply to the presence of metals or their lactates as preservative agents, poisonous to some species and harmless to others, or whether it was due to the oxygen-carrying property or to catalytic action of the metals in question.

The available data on this subject are too limited to be conclusive, but whatever the direct cause of such selective action may be, if such action takes place, our knowledge of the properties of the several

metals suggests that this action would be most intense in the case of copper.

EFFECT OF METALS ON VITAMINS.

The only data reported refers to copper. Copper in milk in quantities taken up by Pasteurization in a copper container diminished the activity of the antiscorbutic vitamin. Knowledge as to the effect of copper and other metals on other types of vitamins present in milk and milk products is entirely lacking.

PROPERTIES OF THE PRINCIPAL METALS USED IN DAIRY EQUIPMENT.

The following are some of the outstanding properties of metals used in milk work as related to their suitability for dairy equipment.

Iron and steel are readily oxidized and corroded by air, water, acid, salt, and brine. Their high solubility in even weak solutions of lactic acid causes them to contaminate milk and milk products with relatively large amounts of iron lactate. Iron lactates have a marked metallic taste, causing the dairy product so contaminated to become metallic in flavor. The presence of even small amounts of these metals and metallic salts accelerates the deterioration and spoilage of dairy products. Iron and steel are oxygen carriers and catalyzers. It is therefore conceivable that deterioration of dairy products contaminated with them is attributable to oxidation and catalysis.

Protection against rapid corrosion of these metals in milk work by tinning their surfaces has proved successful only in the case of sheet iron and drawn steel. Cast iron and wrought iron do not yield satisfactorily to tinning on account of their porosity. The tin coating does not last and corrosion goes on. Even in the case of sheet iron and drawn steel, the tinning is not permanent, as traces of the acid flux used to prepare the surface for the tin may remain and thereby tend to continue its corrosion under the tin coating.

Tinned sheet iron is suitable largely only for small dairy equipment, such as weigh cans, shipping cans, milk pails, and similar utensils. It lacks in rigidity, strength, and durability to justify its use in the construction of the larger and more expensive equipment, such as is required for the efficient and economical handling of large volumes of milk and milk products, and where rapid heating and cooling are essential. Its lack of rigidity and strength makes prohibitive rapid heating by the use of steam under pressure, and its low resistance to corrosion precludes rapid cooling by the use of brine.

Drawn steel, tinned, also has found application in milk work largely only in the case of small equipment, such as milking pails, etc., on account of mechanical difficulties encountered in the tinning of drawn steel of large equipment.

Copper.—Because of the ease with which copper lends itself to the most diversified forms of construction, its strength and its durability, its high thermal conductivity, its relatively great resistance to corrosion by air, water, and brine, copper has proved most serviceable in dairy equipment, especially for flash Pasteurizers and flash coolers, heating and cooling coils, vacuum pans, sanitary milk pipes, etc.

While copper is relatively resistant to lactic acid solutions, the lactates of copper have an intensely metallic taste, and their presence in even very minute quantities is capable of giving milk and milk products a metallic flavor. Copper is an oxygen carrier and an active catalyzer. Just like iron, so do copper and its salts, even when present in very minute quantities, either induce or accelerate, or both, chemical changes in butter and other milk products, that hasten their deterioration. The action of copper in this respect is much more intense than that of iron and iron salts.

For these reasons the use of equipment in which milk, cream, or other milk product is exposed to large surfaces of copper is dangerous to the quality of the dairy product. This danger is especially great in the case of equipment used for prolonged holding. Oxidized and tarnished surfaces of copper are far more damaging to the dairy product than clean, bright, polished surfaces.

Copper can be used in all types of dairy equipment with reasonable degree of safety if the copper surfaces are efficiently and completely coated with tin and if the tinning is renewed as fast as the tin wears off sufficiently to expose the base copper.

The tin coating on much of the copper used in milk products plants is too thin and entirely insufficient to protect adequately and lastingly the dairy product against the detrimental action of the copper.

Nickel.—The high cost and difficult machinability of nickel have so far limited the use of solid nickel equipment. For this reason experience with nickel in milk work is not extensive and our present knowledge regarding its behavior in dairy products plants is incomplete. However, nickel is available in a high state of purity. It is a metal of great hardness, rigidity, and durability. It shows relatively high resistance to oxidation and corrosion. These properties recommend its use for dairy equipment and, where it has been used, it has been found to have no detrimental effect on the milk product, in spite of its well-known property as an active catalyzer. Its use for nickel plating other metal, such as iron and copper, however, has not proved satisfactory. The nickel coating readily peels off.

Aluminum.—Its exceptional lightness and its ready machinability are its chief advantages. Its principal objections for dairy equipment lie in the fact that aluminum is readily attacked by humid air, water, weak alkalies, weak acid, and brine. It is subject to copious pitting and therefore becomes objectionable from the sanitary standpoint. The pitting is largely due to the impurities contained in the metal. Of recent years the purity of aluminum has been materially improved, and this may help to minimize its tendency to pit. Its solubility in lactic acid is relatively high and its lactate has a distinct metallic taste. No data are available to show that it is either an oxygen carrier or catalyzer. Aluminum has proved serviceable for small equipment and utensils, such as milking pails, etc. Its softness and low resistance to rough handling render it unsuitable for milk and cream shipping cans. Aluminum does not respond satisfactorily to tinning.

Alloys of metals.—These include such alloys as German silver, nickel silver, white metal, milk metal, monel metal, bronze, and other similar alloys containing copper.

The chief advantages of these alloys are their strength, rigidity, and durability. Their resistance to lactic acid is relatively high. They do not tarnish as readily and always look better than iron, copper, aluminum, and similar base metals.

In spite of these admirable properties, they have not proved as suitable for milk work as their appearance promised. They produce lactates with intense metallic taste and they appear to accelerate the deterioration of milk products. Both their structural composition and their action on milk and milk products suggest that these alloys are capable of inducing electrolytic action in milk, and that this electrolysis, therefore, may be one of the causes of their unfavorable action on milk products.

While German silver has been found serviceable for flash Pasteurizers, none of these alloys can be recommended for open heaters, open coolers, holding tanks, sanitary piping, etc. However, their surfaces can be readily tinned, and the detrimental effect of their contact with milk products avoided in a similar way as in the case of tinned copper. But if such tinning is necessary, there is no advantage in using metals more expensive than copper.

Bronze has been found very suitable for bearings, pump linings, valves, etc., because of its superior hardness. Unless bronze is tinned, its action on milk is similar to that of the other alloys, but its use for the above purpose exposes only comparatively small surfaces to milk, and its danger of injury to the quality of the dairy product therefore may be considered negligible.

Glass-enameled steel.—The introduction of glass-enameled steel in dairy equipment is of comparatively recent date. While glass-enameled tanks have been used in condenseries and market milk plants for holding tanks for some 15 years or more, this equipment had to do largely only with sweet milk and condensed milk. Most of these tanks were not jacketed and many were without agitating device. In creamery work and for the handling, heating, and cooling of sour cream they are a comparatively new innovation. For this reason our knowledge concerning their effect on milk products, and especially regarding their durability, is somewhat limited.

However, their performance has so far proved highly satisfactory. According to all indications, glass-enameled steel has no action on the quality of milk and milk products. These experiences, and our general observations of its properties and behavior, suggest that glass enamel of such composition and thickness (two coats) as is now used in dairy equipment, and properly applied to a high grade of steel, covers the surface of the steel completely, and it permanently prevents contact between milk product and steel. These observations further indicate that high-grade glass enamel on high-grade steel, such as is made for and used in milk work, is not attacked by air, is insoluble in water, weak alkalies, and in such concentrations of lactic acid as are encountered in the diverse branches of the manufacture of dairy products. It does not form metallic lactates, and is incapable of inducing electrolysis or catalysis.

To be sure, there are different qualities of glass enamel and of steel, different methods of application, different thicknesses of enamel coating, all of which factors have an important bearing on resistance to acids, alkalies, and other solvents, to wear and to cracking and

chipping, and influence greatly its porosity and its durability. But in its present state of development glass-enameled dairy equipment appears to be of a quality inert to the action of milk products, harmless to their quality, and easily kept clean and in sanitary condition. It, therefore, is looked upon as highly desirable for milk work.

High-grade enamel, as used in dairy equipment, is similar to glass, differing from the latter only slightly in composition. The composition of the enamel is made up of silicates, borates, fluorides, alkaline earths, and alkalies, and such coloring oxides as are necessary to produce the desired color. Dark-colored enamel is preferable to white or translucent enamel, because, on the dark enamel, remnants of milk or cream are more readily seen than on the white. The enamel for dairy equipment should be, and so far as known is, free from lead. The most important difference between glass and enamel is that the enamel has a materially lower temperature of fusion, and the glass-enameled steel has additional physical factors calculated to give it a high degree of expansion and thermal endurance.

Glass enamel is attacked, however, by caustic alkalies, and there are some physical and mechanical features where glass-enameled steel as yet has its distinct drawbacks. The low thermal conductivity of both steel and glass enamel, and the relatively great thickness of the steel (five-sixteenth inch) render such equipment unsuitable for rapid heating and rapid cooling. This means that the use of glass-enameled steel is largely confined to tanks in which to hold the product. While jacketed tanks make Pasteurization and cooling possible in commercial handling of large volumes of milk and cream, these processes are too slow, and there is danger of damage to the physical properties of the finished product. This is especially true in the case of cream for butter making. For this reason it has been found preferable to flash heat and flash cool the product by other equipment and use glass-enameled tanks largely for finishing the cooling and for holding the product in them.

Agitators and fittings used in glass-enameled tanks are as yet constructed of metal not covered by enamel; and to the extent of their presence, the milk product is subject to their action. These parts, however, present relatively small surfaces only, and therefore their effect on the product has so far been negative, but the development and use of glass-enameled agitators and fittings is highly desirable.

Corrosion of the steel on the nonenameled or jacket side of the tanks is a further objection. As brine must be used in order to cool to the desired temperatures with reasonable rapidity, corrosion of the bare steel surface is unavoidable. This corrosion is intensified where the jacket is used for both heating and cooling.

This corrosion may not be significant from the standpoint of shortening the life of the tanks, but is objectionable because of the interference of the rust in the proper functioning of valves, etc., and the deposit of the products of corrosion that may form on the steel may further diminish the heat conductivity of the steel. It seems that so far no treatment has been discovered that will successfully protect the steel surface in the jacket of the glass-enameled tanks against corrosion, but the corrosive action of the brine may

be materially reduced by treating the brine with a suitable alkali free from magnesium and keeping it in slightly alkaline condition.

There is also some danger of damage to the enamel by cracking. This may be caused by accidental dropping into the tank of heavy objects such as pipes or wrenches, etc., and by subjecting the tanks to severe jolts, or to pressure sufficient to change the contour of the steel. Instances of this type, however, are rare and occur generally only in the case of extreme carelessness or exceptional accidents.

Because of its recognized sanitary features and its apparent inability either to add to or cause the development in milk and milk products of objectionable flavors, glass-enameled steel must be considered highly desirable and suitable for use in milk work.

SUMMARY AND CONCLUSIONS.

The foregoing study and discussion concerning the suitability of different metals for dairy equipment suggest the following summary and deductions:

1. All the base metals that have so far found application in the construction of dairy equipment are more or less soluble in lactic acid solutions, and their lactates have a bitter, puckery, astringent, metallic taste. This solubility is greatest in the case of zinc, iron, and aluminum, but the intensity of the metallic flavor per unit of metallic lactate is greatest in the case of copper and alloys containing copper, such as bronze, German silver, white metal, etc., and least in the case of tin, zinc, iron, and nickel.

2. The use of equipment in which large areas or surfaces of bare iron, copper, and metallic alloys, such as bronze, German silver, white metal, monel metal, milk metal, etc., are exposed to milk, cream, and other milk products, is prone to give to the milk product an objectionable, metallic flavor.

3. The presence in milk and milk products of iron, copper, and metallic alloys, or the salts of these metals and alloys, induces or accelerates deterioration of the dairy product. The exact nature of this accelerated spoilage is as yet not well understood, but the results suggest catalytic action by the metals and their salts as at least a contributory cause. In some instances the nature of the spoilage points to bacterial activity, the presence of the metals, their salts, and their oxides exerting a selective action on certain species of bacteria.

4. Metallic alloys, such as German silver, white metal, monel metal, etc., have been found unsuitable also because of their tendency to become pitted, as well as because they have a damaging effect similar to iron and copper, on the flavor and keeping quality of the dairy product. The possibility that most of these alloys may lack homogeneousness of structure suggests that their immersion in milk or other fluid milk product induces electrolytic action. This further suggests that electrolysis, therefore, may be responsible, in part at least, for their accelerated corrosion and pitting, and for their injurious action on the dairy product.

5. Tin and nickel appear to be the only metals under observation that produce no detrimental effect on the quality of milk products in commercial handling and manufacture. The proper tinning

of metals and alloys that have been found to be injurious to milk products, such as iron, copper, and the metallic alloys, diminishes the detrimental effect and may render their use harmless; but the coat of tin must be heavy and must cover all the surfaces of the metals that are in contact with one another, and that are immersed in the milk product, otherwise electrolysis may largely forfeit the benefits of the protective action of the tin coating. Nickel plating has proved unsatisfactory on account of early and rapid peeling off of the nickel coating. Solid nickel equipment has so far produced no harmful effect on milk. Its introduction, however, is of too recent date to warrant final conclusions.

6. Information of the effect of aluminum equipment on milk and milk products is very meager and entirely insufficient to discuss intelligently the suitability of this metal for dairy equipment. The generally known properties of aluminum, however, make it appear that this metal does not lend itself advantageously for large equipment in milk products plants. Its solubility in weak alkalies, weak acids and brine, its low resistance to humid air and water, and its tendency to pit, are seriously objectionable. It is used for milking pails and other small utensils without apparent injury to milk. In the few instances reported where it was used as a part of larger equipment, it pitted excessively and its use was discontinued; but exact information concerning its effect on the milk product is lacking. The profuse pitting may have been due to its impurities. Of recent years aluminum of greater purity has become available.

7. Glass-enameled steel, such as is now used for dairy equipment, has no metallic action on dairy products. It is not attacked by the air, is insoluble in water and in weak acids, such as are contained in sweet and sour milk and cream and other milk products, and in weak alkalies, such as are in general use in the form of washing powders in milk products plants. The enamel is nonporous and, when properly fused in sufficient thickness (two coats) on high-grade steel, it prevents contact of the milk product with the steel. It does not form lactates nor give the milk product metallic flavor, and it is inert from the standpoint of electrolysis and catalysis. Its low thermal conductivity, however, renders glass-enameled steel unsuitable for equipment intended for rapid heating and rapid cooling, such as flash Pasteurizers and flash coolers. It may be used for batch heating and cooling of limited volumes, but where large volumes of dairy products must be handled, it is best suited for tanks in which the cooling is completed and for holding purposes. In the case of jacketed glass-enameled tanks, where the jacket is used for either heating or cooling, or both, the bare steel on the jacket side is subject to corrosion. This may in time further diminish the thermal conductivity of the glass-enameled steel, unless some protective treatment is developed and applied to minimize this corrosion.

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Chairman CHERRY. Before inviting discussion on Mr. Hunziker's paper, I wish to refer to a similar paper that was to have been read by Doctor Seligman, who is not here. A summary of his paper, however, will be given by Doctor Golding, who is head of the chemical department, the National Institute for Research in Dairying, England.

Doctor GOLDING. I was asked by the English committee to read this paper and received a copy of it. I wrote to Doctor Seligman, telling him that it was rather long and asked his permission to cut it down. He has kindly consented to allow me to use a free hand in the matter.

(Doctor Golding read a summary of Doctor Seligman's paper. The paper is herewith published in full.)

MILK AND METALS.

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The application of science to the milk industry has brought a rich crop of improvements into a field which had been cultivated by rule-of-thumb methods since the dawn of history. The attention of those scientists who have devoted themselves to milk problems has, however, been turned almost exclusively to the properties of milk itself, and largely, of late years, to the biological side of the ques-

tion. That this should be so was natural, because herein were the problems most apparent, and progress most easily attainable.

The scientific work which has been done has, however, itself suggested another set of problems to which but scant attention has been paid. Increasing knowledge of the properties of milk has given to the dairy industry fresh means of so controlling those properties as to make milk and its products of greater service to mankind, and as a direct consequence has extended beyond all conception of former days their application to the nutrition of peoples. Almost every advance in knowledge has led to some fresh method of treating milk, and gradually the treatment has become more rigorous in degree or duration.

Moreover, the milkman has, with rare exceptions, availed himself of the services of the metallurgist, and has found it most convenient and profitable to carry out his operations in receptacles made from the metals which the metallurgist has put at his disposal.

Whilst the transition from the wooden tubs and pails of our forefathers to the sanitary metallic utensils of to-day has gone on with ever-increasing rapidity, until to-day the applications of wood to dairy utensils can almost be counted on the fingers of one hand, hardly any attention has been paid by those engaged in the industry, whether they be practical milkmen or scientists, to the properties of the metals they are using, or to the interaction of milk and metal.

So it has come about that whereas, on the one hand, those who deal with milk have widened their horizon immensely and have increased in all directions their knowledge of milk; and whereas, on the other hand, metallurgists have brought new metals into existence, and have given the world an insight into their structure and properties, scarcely any attempt has been made to bring these two fields of scientific activity into correlation, or to study the close interplay which must exist between the properties of two materials which are in contact with one another under a great variety of physical, chemical, and mechanical conditions.

Let it be remembered that under modern conditions milk and metals come together at all temperatures from, say, 20° C. to 150° C., at all pressures from 100 pounds per square inch down to complete vacuum, mixed intimately with gases which may promote corrosion or with no gases whatever. Each of these factors has been found to play an important part in other branches of research.

In Europe, so far as the writer is aware, hardly any systematic study of the metals used in the construction of milk and dairy apparatus has been made public, whilst in the United States the sole published contribution to this subject appears to have been the work of Donauer (1), whose paper on the rate of attack of milk on various metals has appeared in *The Ice Cream Review*, a publication which but rarely crosses the Atlantic. Scattered throughout the literature of both the branches of science involved are isolated statements which in some cases refer to facts of the greatest importance to the dairy industry, but no attempt has been made so far to bring them together into an authoritative and conclusive account of the subject.

The present writer can not hope to present any such statement, nor, if he were in a position to do so, would this be a suitable occasion. His object in these notes has been confined to drawing attention to the great importance which the subject is assuming, and to pointing out several directions in which research is badly needed.

Before proceeding, it is necessary to say that these notes are written by one who has devoted many years to specialized study of one of the metals to be discussed, namely aluminum, and that it would not be unnatural if his views were colored by his close association with that metal. Every effort has been made to consider the subject without any bias; but whether he has been successful in this or not, the writer feels satisfied that, having made this his apologia, his objects in compiling these notes will not be impugned.

To deal with materials of construction, generally, would lead far beyond the limits which the writer has set himself, and it is proposed to consider only those metals with which milk actually comes in contact during the normal course of dairying processes. By this limitation, iron and steel in their ordinary forms are excluded, because it is only when the coatings applied to them are defective that they come in contact with milk. Reference will, however, be necessary to certain special steels.

The metals concerned are, in their alphabetical order: Aluminum, copper, nickel, tin, zinc.

To these must be added the following alloys of: Aluminum with zinc and copper; copper with nickel, zinc, and tin; iron with carbon and chromium; tin with lead.

Each of these metals and its principal alloys must be considered from a number of distinct points of view. These may be profitably classified under the following main headings:

- I. The effect of the metal or the ingredients of the alloy on milk.
- II. The effect of milk on the metal or alloy.
- III. The physical and mechanical properties of the metal or alloy.

The first two form the subject of the following notes, the third is not suitable for discussion here.

I. EFFECT OF METAL ON MILK.

Dairymen and scientists alike will agree at once that the first consideration should be given to the effects of any material used for the construction of dairy plant upon the milk which the plant is designed to contain. Not only do such questions as the effect on flavor and keeping qualities of milk and its products arise under this heading, but also the vital question of the toxicity of any metallic salts which might find their way into the milk. The importance of this last factor can not be overrated, and it should therefore be the first subject to be considered. For this purpose the pure metals and their alloys can be discussed as one.

The information available on the subject of toxicity is by no means adequate, and to this fruitful field for research the writer would draw the attention of those who have the facilities for carrying out investigations into the toxicity of metal salts in the presence of such a fluid as milk.

Taken in order of toxicity, the metals in question should, in all probability, be arranged in the following series:

1. Chromium.
2. Copper.
3. Zinc.
4. Lead.
5. Tin.
6. Nickel.
7. Aluminum.

In presenting such a table as this, it is necessary to do so with considerable reserve, because, as stated above, it is not clear to what extent the milk itself modifies the toxic properties of the metallic salts in question. It may be said confidently, however, that appreciable quantities of the first members of this series dissolved in milk would be extremely dangerous to health, whilst even large quantities of nickel would be of comparatively little importance. Aluminum salts are, as is well known, not poisonous at all, and are normally present in one form or another in most foodstuffs.

In considering the effect of the metals cited above upon the health of human beings it must be remembered that the effect of those which are toxic is in most cases cumulative, so that whereas the consumption of a small dose may be innocuous, continued consumption of even minute quantities may prove highly deleterious. Such continued consumption is most likely to occur where contamination is due to faulty plant.

The effect of metals on the flavor of milk may be twofold. In the first instance there is to be considered the taste imparted to the milk by the metallic salts dissolved. Our knowledge on this subject is extremely limited, and yet whenever a new metal or alloy is under consideration for dairy purposes its effect on the flavor of milk or milk products is one of the first questions which arise in the minds of all dairymen.

Mojonnier and Troy, in their book, *The Technical Control of Dairy Products*, refer to some work done by Professor Erf on this subject, but the work itself has apparently not yet been published. It is very desirable that exact information on a subject of such great importance should be forthcoming, as its bearing on the design of dairy plant is considerable. Above all, it is necessary that researches into a subject such as this be reported with all the detail which a scientific treatise demands. Only in this way can those who have to make use of the published results judge of the value to be attributed to them. Moreover, it is only in this way that standard methods of investigation can be elaborated and made applicable to new metals or alloys as they are brought into the field from time to time.

This is well illustrated by the brief account which Mojonnier and Troy give (*loc. cit.*) of Erf's work on the influence of metals on the flavor of milk. If he is correctly reported, Erf added his metals dissolved in a mixture of lactic and citric acids, thus changing entirely the proportions of these acid radicals in the milk, and probably increasing the acidity at the same time. It would, of course, be entirely improper to criticize work the barest outline of which is alone available, and the foregoing is mentioned in no sense as criticism, but merely to point out that only by the publication of the conditions

of experiments in their fullest detail can progress be achieved. Similarly, it is entirely misleading to base conclusions as to the effect of metals on the flavor of milk upon the effect of one of their salts on distilled water, as Donauer (1) appears to have done. To do so is to ignore those other ingredients of milk which in all probability play a determinative part.

It can only very rarely occur that the metals are dissolved in sufficient quantities to convey their own characteristic tastes to milk, but, as will be seen when discussing the effect of milk on the metals, such cases may, and occasionally do, arise (2).

It may therefore be desirable to point out that the salts of copper, nickel, tin, and zinc all give a metallic, inky taste to liquids containing them, whereas the salts of aluminum are merely astringent. The salts of chromium may be sweet or astringent, according to the form in which they are present. The soluble salts of lead have an unpleasant sweetish taste.

Much more important than the actual taste of the metal salts is the effect which such salts have on the flavor of the milk itself. The writer is unaware of cases in which this has been noticeable in fresh milk,¹ but there is definite evidence that even very small quantities of copper, tin, or zinc dissolved in milk may bring about changes, probably of a catalytic nature, which seriously affect the flavor of certain milk products, such as condensed milk, dried milk powder, etc. He has so far not heard of any such occurrence with aluminum or nickel salts, although with nickel, catalytic effects are obviously to be expected.

Chromium salts, in spite of their toxicity, have in the past actually been used for the preservation of milk, so that it is unlikely that changes affecting the flavor of milk would take place in their presence. (4)

Here again, the writer ventures to point out, is a field for exact investigation, which would have a direct and important bearing on the design of milk products plant.

II. EFFECT OF MILK ON METAL.

The effect of milk on metals and their alloys is extremely difficult to subject to examination with the necessary scientific precision. There is a great deal of accumulated knowledge with regard to the older materials, but this is of little help in evaluating the suitability of the newer materials which recent advances in metallurgy have placed at the disposal of dairy engineers.

It is customary in investigations of this character, which deal as a rule with the baffling phenomena of corrosion, to subject the metals to be tested to the action of the solutions with which they are to come in contact, the conditions to be anticipated in practice being simulated as nearly as possible. As it is desired to ascertain in the course of a few days or weeks what the behavior of the metals is likely to be over a period of years, these conditions are as a rule accentuated so as to produce results in a comparatively short time. Either the solutions

¹ Since the above was written the author's attention has been drawn to a most interesting communication by Golding and Feilman, (3) Jour. Soc. Chem. Ind., v. 24, 1905, in which fresh milk was shown to be affected by copper in this way.

are made more corrosive, or their attack is continued uninterruptedly instead of intermittently, as is generally the case in practice.

It is always a matter of extreme difficulty so to order experiments that they truly represent practical conditions. It is doubly difficult to do so if the conditions are to be accentuated in any way, and the difficulties become almost insuperable where a material such as milk is the corrosive agency. Not only does milk form a highly complex mixture of bodies, some of which promote, whilst others inhibit corrosion in varying degree according to the metal or alloy to be experimented with, but its properties also change rapidly with the production of ever varying proportions of corrosive or protective bodies. The scientist is faced at the outset with the loss of his favorite weapon, the modification of one condition only at a time until the effect of each can be ascertained, and the replacement of this weapon can be the result only of great expenditure of time and un-failing patience. Attention need only be drawn to the following list of the salts present in milk according to Söldner (5) to indicate the number of factors which must be taken into account.

Milk salts.

	Grams per liter.
Sodium chloride -----	0. 962
Potassium chloride -----	0. 830
Monopotassium phosphate -----	1. 156
Dipotassium phosphate -----	0. 835
Potassium citrate -----	0. 495
Dimagnesium phosphate -----	0. 336
Magnesium citrate -----	0. 367
Dicalcium phosphate -----	0. 671
Tricalcium phosphate -----	0. 806
Calcium citrate -----	2. 133
Lime (in combination with casein) -----	0. 465

If recent views (6) of the part played by colloidal bodies in promoting or preventing corrosion and the nature of some of the organic constituents of milk are borne in mind, the problem is seen in its full complexity. It may be added that the suggestion has been made recently that even the destruction of the enzymes in milk by high-temperature Pasteurization is sufficient to change completely the interaction between milk and metals.

Here, then, is another field for investigation which might well occupy the undivided attention of many chemists whose success, if it were attained, would be of inestimable value to the dairyman and the dairy engineer.

It has been approached in the United States by Donauer (1), who has tested the amount dissolved from unit surface of various metals and alloys by fresh milk at various temperatures.

Unfortunately, Donauer merely states his conclusions without describing in any detail his experimental methods, so that his results, some of which are open to grave question, can not be profitably discussed.

The writer and Mr. P. Williams have also adopted this method in studying the one metal with which they have been most concerned, but they have also had recourse to the alternative method of trying to determine which of the ingredients in milk promote, and which inhibit corrosion, with a view to the ultimate evolution

of reliable intensified tests. It is not surprising that in so complex a field but little progress should have been made, but one or two facts have already emerged to which it may be well to make the briefest of references here.

Thus, for instance, it is already apparent that the various acids present in milk act selectively, a metal attacked most rapidly by one acid remaining comparatively resistant to attack by other acids. So, also, the effect on metals attacked by some of the acids alone is found to be comparatively mild, but to be largely increased owing to the presence of the chlorides which form a regular constituent of milk. That a mixture of the acids and chlorides known to be present in milk in the dilution in which they normally occur, attacks all the metals far more rapidly than does milk itself, is evidence, if evidence be needed, of the protection exerted by other bodies present with them in milk.

It is felt that complete knowledge on this side of the subject is likely to prove of great value, because many of the processes to which milk is subjected bring about changes in the relative proportions of the different ingredients. It is highly desirable, therefore, that other workers should attack the question of the influence of milk and its products on metals by similar means.

Another phenomenon which is of importance is the effect of one metal upon another when the two are exposed together to milk or its products. Here, again, the different ingredients of milk may cause one or other of a pair of metals to suffer by their contact. As an example, it may be pointed out that there is evidence, though by no means conclusive evidence, that if perfectly tinned copper be exposed to attack by mixtures of lactic acid and chlorides on the one hand, and dibasic calcium citrate and chlorides on the other hand, the rate of attack is, in both cases, substantially the same. If, however, the tin coating be imperfect, the results appear to be very different. In the former case, copper appears, under some conditions, to pass into solution more rapidly than the tin which is in some measure protected, whilst in the case of the citric acid mixture the copper is protected, but the rate of attack on the tin is greatly enhanced.

Similar anomalies, or what at first sight appear to be anomalies, are found on many sides. If, for instance, aluminum and iron be exposed together to attack by sour milk, the aluminum is corroded and the iron left comparatively intact, although if the two be placed together in a 1 per cent solution of lactic acid, the iron is electropositive and passes into solution, thus protecting the aluminum. If, however, another ingredient of sour milk, potassium chloride, be added to the lactic acid, the polarity of the couple is immediately reversed, and complete analogy with the sour milk is established. If now the iron be replaced by zinc, no such reversal takes place, the zinc remaining throughout electropositive to the aluminum, and protecting it. It has been found possible to apply the knowledge of this fact, with marked success, in commercial practice.

The writer suggests that attention to these phenomena might also bring results of value to the whole industry.

Passing now from what may be termed the "laboratory" side of this inquiry, the behavior of the various metals and alloys in daily practice may next be considered. With regard to the older metals, copper, tin, zinc, and lead, so much experience has been accumulated and is so widespread that there is no need for any extended discussion here. One or two points may, however, be briefly referred to.

It is well known that copper is amongst the more poisonous of metals, and the question arises as to whether sufficient copper can get into solution to cause trouble. There appear to be two possibilities. If improper cleansing or sterilizing fluids be used, considerable quantities of copper may be dissolved, and if small quantities of the resulting solutions gather in pockets or other recesses in the plant and are not dislodged before milk is admitted, the first runnings from the plant may be seriously contaminated.

A second source of trouble arises if the plant be not thoroughly cleaned after use; especially, if it be not used again until after the lapse of an appreciable interval. In such cases the material left in contact with the copper may develop a high degree of acidity, and sufficient copper may be dissolved to cause injury to health. A case recently came to the notice of the writer where the first runnings from a tubular heater used for Pasteurizing were so heavily contaminated with copper as to give rise to serious digestive disturbances.

In the case of tin, trouble is only likely to arise where tin is used as a coating and that coating is defective. It has been shown that tin, exposed in contact with copper to attack by some weak acids, may be dissolved with comparative rapidity. With other weak acids the defective tin coating may entail enhanced solution of the metal it is supposed to protect. It seems necessary to point out, therefore, that danger may arise if the tin coating which is generally applied to copper vessels in the dairy be broken through, and that such coatings should be kept in perfect order or dispensed with entirely. In the latter case the dairyman is not likely to be lulled into a sense of false security and, knowing that copper at any rate must be kept scrupulously clean, will give more attention to his plant than if he wrongly believes himself protected by tinning, which is really faulty. It should be remembered that the effect of tin is cumulative.

Lead is only likely to give trouble in the dairy if it is used in excess in the alloys with tin used for coating or soldering metals.

Zinc is so seldom used in contact with milk that the metal itself, as distinct from alloys containing it, needs very little consideration. Some dairymen do, however, use galvanized piping for conveying fresh milk, and it is, therefore, desirable to say that in view of the ready solubility of the metal, its use for such a purpose seems highly undesirable.

An alloy which has been used for a long time in dairy equipment is the alloy of copper, zinc, and nickel, which is variously known as German silver, or nickel silver. This material is comparatively resistant to attack by the weak acids in milk and the cleansing materials more generally in use in dairies. It is noteworthy, however, that

when attack does take place it is mainly copper which passes into solution.

Turning to those metals and alloys which have been introduced more recently for the construction of dairy equipment, it will be convenient to consider, first, aluminum and its alloys.

Although aluminum has been used very little in the United States for dairy plant and apparatus, it is widespread in European dairies, more particularly in Switzerland, Denmark, Germany, and Great Britain.

The solubility of aluminum in milk varies according to the physical state of the metal.²

Wrought metal of adequate purity is, indeed, very sparingly soluble, but on metal in the cast state, attack is comparatively rapid. Thus it comes about that whereas, tanks, cans, etc., made of aluminum sheet may be found unchanged after 10 years of constant use, cast fittings to the same vessels may give out after a few years. Certain precautions are essential to the successful application of aluminum to the dairy industry, but where these are observed the results are highly satisfactory.

Aluminum possesses two drawbacks. One is that it is necessary to make special provision to prevent or minimize the effect of contact with other metals; the other is that such dissolution as does take place is under some conditions highly localized. Reference may be made in this connection to a report recently published in *The Dairyman* (7) of a meeting of Swiss dairymen at which this subject was very fully discussed.

Aluminum possesses one advantage over almost all the other metals used for dairy plant, in the facility with which joints can be made which are in no case likely to become defective and so provide harborage for dirt or bacteria.

² Donauer is reported (1) as stating that 20 milligrams of aluminum are dissolved per 24 hours per 100 square centimeters of metal exposed to milk testing 0.20 per cent lactic acid at 65° C. No details are available to the writer as to how this remarkable figure was obtained, but it is certainly utterly inapplicable to the aluminum used on a large scale for the production of aluminum dairy plant in Europe. The writer, in addition to many years of experience of the metal in European dairies, has, with Mr. P. Williams, subjected aluminum to numerous laboratory tests, of which the following is an example:

Two samples of aluminum in the form of hard-rolled sheet containing 0.28 per cent silicon, 0.46 per cent iron, 0.01 per cent copper, 0.01 per cent zinc, and 99.24 per cent aluminum (by difference) were cleaned by immersion in caustic soda, and subsequently washed with water and dried. The samples were then submerged in milk "testing 0.162 lactic acid" (100 cubic centimeters = 18 cubic centimeters $\frac{N}{10}$ NaOH) contained in Jena glass boiling tubes. The milk was retained at 65° C. in a thermostat. One sample was withdrawn after one hour, the other after six hours, and cleaned by water, followed by an ether-alcohol mixture. The following figures were obtained:

Sample.	Area.	Weight.		Change in weight.	Duration of test.	Metal dissolved per 100 sq. cm. per 24 hours.
		Before test.	After test.			
	<i>Sq. cm.</i>				<i>Hours.</i>	
I.....	47	1.4372	1.4372	Not measurable...	1	Not measurable.
II.....	47	1.3938	1.3938	.....do.....	6	Do.

The above results are typical of many obtained.

No case of rapid dissolution such as Donauer reports has ever been noted with aluminum of the quality and in the form described above. Similarly, Donauer's results with aluminum in other media are totally at variance with those obtained by Mr. Williams and the writer.

It is necessary to discuss the effect of the cleansing agents in common use in dairies upon aluminum. Soda, which is the most common of all, while it may be used for cleaning aluminum by expert hands, is detrimental if used without precautions, and results in deep staining and, in extreme cases, rapid attack on the metal.

In Switzerland it has been customary to use in place of soda, hot soap solutions, which effectively remove fat and apparently do not injure the metal at all. More recently it has been found (8) that soda can be used with complete impunity if a small quantity of silicate of soda is incorporated with it. Alternatively, any of the mixtures of soda and silicate of soda which are articles of commerce in all parts of the world may be used as effective and safe detergents for aluminum.

Whilst the writer shares the view expressed by the above-mentioned Swiss conference that aluminum in the form of pure sheet is in many respects an ideal metal for the construction of dairy plant, he has so far failed to find any of the alloys of aluminum which offer any hope of proving suitable for the purpose.

Nickel, which has been used to a small extent for milk plant, is likely when in an adequate state of purity, to prove highly satisfactory, from a chemical point of view for many purposes in the dairy. It is true that careful experiments have shown it to be much more readily soluble in many of the weak acids present in foodstuffs than has been generally assumed, but it offers the great advantage compared with all the other metals in question, except aluminum, that even if solution take place, little harm is likely to result. At present the metal suffers from the grave defect that, owing to the difficulty of manufacturing it of perfectly uniform quality, a considerable amount of variability is met with, and in some cases the high qualities of the pure metal can not be relied upon. One other feature militates against its wider use, and that is, that suitable methods of joining sheets of nickel are known to only very few. When this knowledge is more widespread, the writer confidently expects to see a considerable development in the use of this metal, which is not only very sparingly affected by milk, but remains unattacked by all the ordinary detergents in use in dairies.

An alloy of nickel and copper, known as monel metal, has been widely advocated for the construction of dairy equipment. In the United States it has apparently been used to some extent, but it is believed that the early hopes reposed in this alloy have led to some disappointment.

This is not surprising because experiments made with it have shown that monel metal is somewhat readily attacked by the weak organic acids present in milk, whilst the products of such attack are largely toxic copper salts.

The last metals, or rather alloys, to be considered in these notes are the chrome steels, known generally as rustless steel or rustless iron. These materials when suitably prepared are remarkably resistant to milk, and from this point of view appear to be destined ultimately to play a large part in the construction of dairy plant. Their use on a large scale must, the writer thinks, lie in the future on account of three adverse factors. The production of the material of sufficiently uniform quality appears still to be a matter of extreme

difficulty, and slight variations of physical or chemical composition rob these remarkable steels of their acid resisting properties entirely. The construction of large scale dairy plant of chrome steel is also rendered very difficult by the fact that suitable methods of jointing, which do not affect the valuable properties of the alloys, are not available.

The most serious obstacle to the wider introduction of these steels appears to lie in the extraordinary effect of contact with other metals upon their acid resisting properties. Steels which are totally unaffected by immersion in weak organic acids may be completely perforated in a short time if subjected to attack by these same acids when in contact with gun metal or copper. This property is likely to be a source of much difficulty.

In concluding these notes, the writer ventures to express the hope that they may indicate the lines along which investigations may be profitably conducted, and that they may induce those who have the necessary facilities to devote themselves to the solution of some of the many problems presented by the contact of milk and metals.

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Chairman CHERRY. Gentlemen, do you wish to discuss Doctor Seligman's paper? Are there any questions you wish to ask? If not, we will proceed with the next paper, which is "Continuous flow holders used in Pasteurization, especially in regard to the time factor, from a bacteriologist's viewpoint," and which will be presented by Mr. C. S. Leete, market milk specialist, United States Department of Agriculture. [Applause.]

CONTINUOUS FLOW HOLDERS USED IN PASTEURIZATION, ESPECIALLY IN REGARD TO THE TIME FACTOR, FROM A BACTERIOLOGIST'S VIEWPOINT.

CHARLES SIDNEY LEETE, market milk specialist, Dairy Division, United States Department of Agriculture.

In order to discuss any class or type of equipment it is necessary to determine what such equipment is expected to accomplish. In the case of Pasteurizers, when properly operated, it is rightly assumed that the requirements of Pasteurization can be readily carried out. Proper Pasteurization of milk means the holding of every particle of milk at a temperature of 145° F. for 30 minutes. Exposure at this temperature and for this length of time, will kill all pathogenic bacteria which may be present, and will also allow a

margin of safety which has been found necessary when milk is Pasteurized under commercial conditions. Every Pasteurizer should be so designed and constructed as to make it positive that, when in actual use, the requirements of Pasteurization are fulfilled. Bacteriologists view Pasteurization of milk from a public health standpoint, namely, from the standpoint of safety. In order to insure a safe milk by means of Pasteurization, the time and temperature requirements must necessarily be assured. Certain systems of Pasteurization may result in the finished product having a low bacterial count, without assuring a safe milk. Pasteurization temperatures, applied for a short time, will kill a large percentage of the bacteria ordinarily found in milk. However, because of the resistance of certain pathogenic bacteria, such a process will not bring about their destruction. Killing all pathogenic bacteria which may be present in milk is the object of Pasteurization. The time at which the temperatures used in Pasteurization are applied is one of the most important factors entering into this question. Therefore, any system of Pasteurization which does not give positive assurance that every particle of milk has been held for 30 minutes should be viewed with suspicion in so far as the safety factor is concerned.

Continuous flow holders, used in Pasteurizing milk, are so made as to allow a continuous flow of milk through the apparatus from the inlet to the outlet (cooler). Various designs have been made and placed on the market, varying from a simple tank with baffle plates, which aim to retard the flow of milk, to a series of pipes and tanks, with various distributors and collectors.

Many designs of collectors and distributors have been made. The idea in each case has been so to distribute and collect the milk in the holding tank as to overcome or minimize the effect of currents. Theoretically, machines of the continuous flow type are made and arranged in such a manner as to retard the flow of milk to such a degree that milk, entering at the inlet of the holders, will not be discharged at the outlet until 30 minutes later. Various plates, tubes, and tanks are used in the effort to control the flow through the machines. From observations and tests made, it is believed that milk Pasteurized by this system should be studied from a qualitative bacteriological analysis as well as a quantitative one.

After the tanks or apparatus have been filled, we can not readily observe whether or not milk subsequently entering the Pasteurizer is held exactly 30 minutes or whether the holding time is below or above that figure. Some special tests must be used. Literature regarding the holding time of continuous flow Pasteurizers is lacking.

In order to study the holding time, several different tests have been used. The principle in all cases is practically the same; i. e., the determination of the elapsed time taken by some substance to pass through the machine from the inlet to the outlet, after the apparatus has been completely filled with water and is running at its rated capacity. Ordinary tap water is usually used due to the economic waste which would result were milk the medium employed. When the size of the pipes, tanks, and surfaces met with in commercial apparatus is considered, the action of tap water at ordinary temperature is comparable to that of milk at 145° F. For these tests the dif-

ference in the action between water at 55° F. to 65° F., and milk at 145° F., is negligible.

Various colors (dyes), chemicals, and thermal observations have been used in making holding time tests. Disadvantages of a serious nature are encountered when the tests have been run using colors, chemicals, and difference in temperature as indicators. Such factors as specific gravity, diffusion, and dilution make these tests inaccurate. If dyes or chemicals are used and the specific gravity is either above or below that of the water used, the holding time as determined by such indicators will either be longer or shorter than the correct time, depending upon whether the dye or chemical rises or falls.

Diffusion of the agents used may in some cases be so great as to affect materially the results.

Due to the degree of dilution which takes place when either a chemical or dye is used, it is readily seen that when the samples are taken at the outlet, the first traces of the indicator would pass by undetected. In the tests where thermal observations are used, only a very broad approximation of the holding time results. The method is essentially to run the apparatus with water, as is the case when dyes and chemicals are used, and to subject the incoming water to a sudden great change of temperature and note the time when a relative corresponding change in temperature is observed at the outlet. Due to the absorption and dispersion of heat throughout the apparatus, this method is very unreliable.

The ideal test to use in determining the holding time of continuous-flow Pasteurizers would be a test using sterilized milk, running the machine at its rated capacity in the regular manner and heating the milk to 145° F. While the machine is thus operating, introduce a bacterial culture of a characteristic organism at the inlet and determine the time required to recover the same organism at the outlet. Compute the holding time as the elapsed time from introduction of the organism at the inlet and its recovery at the outlet. Such a test, however, is impractical, due to the fact that as yet no suitable organism which will withstand Pasteurization has been found; also, for routine work such a test would be very expensive, for milk so treated would be an economic loss.

The Department of Agriculture has devised a test which is simple, practical, inexpensive, and accurate. This test in principle is similar to the color test. It is run in the same manner, but the dye or color is replaced by an aqueous suspension of a characteristic bacterial culture. When run in conjunction with a color test it has proved to be more sensitive. In order to compare these two tests, runs were made in which a suitable dye was placed in the bacterial culture, thus assuring that both indicators would be introduced at identically the same time. The runs were made as heretofore described. The test organism in each case was recovered in a shorter time than was the color (dye) observed. It is logically assumed that minute particles of the color passed through the outlet before they could be detected by the eye. In the case of the bacterial culture, the presence of even one organism in the sample is detected. This fact makes the bacterial test very sensitive, and therefore gives more nearly the actual holding time than a test in which more or less concentration of the indicator is necessary for detection. It is also believed that the action

of a bacterial culture in water more nearly simulates the action of bacteria in milk when compared with either dyes or chemicals.

Any organism used for this purpose, under field conditions, should be easily identified, nonpathogenic, uncommon in water supplies, easily killed, and easily cultivated. After considerable laboratory work a strain of *B. prodigiosus* was selected. This particular organism fulfills all the above requirements. Its very characteristic bright red, luxuriant growth in agar makes it easily identified. One precaution, however, must be taken in its cultivation. It must be grown and stored at room temperature. Temperatures greatly above or below will result in loss of color. If such condition develops from this or any other cause inoculation of the organism every six hours into sterile milk will bring about a return of the bright red color.

In making cultures ready for the test the following procedure is followed. Twenty-four-hour-old cultures on agar slants are washed off in approximately 100 cubic centimeters of sterile water. Three slants are sufficient for a 4,000 to 6,000 pound machine. The water with the washed cultures is then shaken and filtered through filter paper. The filtrate is used for this test. The method of making the test in detail under field conditions is as follows:

Use of a Pasteurizing plant is secured and the test is made either before or immediately after the regular run of milk. The holders, together with the necessary pumps, heaters, etc., are cleaned in the usual manner. The outfit is completely filled with ordinary tap water. Also, the supply tanks are filled with sufficient water to run the apparatus at its rated capacity for 30 minutes. A sufficient water supply is imperative. After the outfit has been filled the pumps are started, or in the case of gravity-filled tanks the valves are opened. In this test it must be remembered that the water is run through at ordinary temperatures, rather than at Pasteurization temperature. Constant checks upon the quantity of water passing through the machines are made at the outlet, in order to regulate the flow. This is done by actual measurement and timing. These checks are made at frequent intervals during the run. The rate of flow should always be constant and should correspond to the rated capacity of the holder. Samples of water for bacteriological analysis are taken at the supply tanks, at the inlet of the holder, or as near this point as possible, and at the outlet. These samples serve as bacteriological checks upon the water and apparatus.

The test organism is then introduced at the inlet to the holder and the time noted. In some types of machines it is impossible to introduce the culture immediately into the holder. The culture is then placed at the entrance to the heater. This should in nowise detract from the accuracy of the test, for the time taken in passing through the heater is relatively short, and a portion of this time may be considered a part of the holding time, in that the milk while in the heater has reached the proper Pasteurizing temperature.

Samples of the effluent are collected at the outlet, the time in each case being noted. These samples are for bacteriological analysis, and must be taken aseptically. Sterile test tubes can be used for the collection of samples. The greater the number of samples taken, the more accurate will be the results. For ordinary purposes, samples taken at 3-minute intervals for a period of 18 minutes, and

then every minute up to 30 minutes will give accurate results. For additional study and information, samples should be taken up to 45 minutes. All samples taken, including the check samples, are then plated. One cubic centimeter of each sample is plated direct on a plain agar medium. The plates are incubated at room temperature for 48 hours. At the expiration of this time a study of the plates is made. The holding time is computed as the elapsed time between introduction of the organism at the inlet and its recovery at the outlet. The identification of the test organism is easily made, macroscopically, due to its very characteristic luxuriant, bright red growth. In all cases, the check samples secured before the organism was introduced must be negative—that is, show no red colonies—if the test is to be relied upon.

Due to the thermal death point of the organism, the apparatus, after being tested, can be easily sterilized. Ordinary methods used in cleaning and subsequent steaming will kill all the test bacteria. In no case where we have used this test has infection of the plant or milk subsequently Pasteurized taken place.

Results of studies made with the test upon continuous flow holders, both under actual commercial conditions and in the laboratory, point to the fact that careful qualitative bacteriological analysis of milk Pasteurized by this method should be made. It must be remembered that a low-count milk does not always mean a safe milk. If apparatus which produces a low-count milk and yet does not hold for 30 minutes is used, the bacteriologist must view such apparatus with distrust, for the safety factor is not assured. In many instances, the actual flow through the machine does not coincide with the theoretical flow.

From the viewpoint of a bacteriologist, Pasteurization means not only a low count, but a safe milk. A temperature of 145° F. for 30 minutes is essential for safety. Manufacture and use of continuous-flow holders should be based on actual bacterial tests rather than on estimates and theoretical flow. With other types of holders, especially those having numerous valves and cams, where there is a chance of leakage, or the holding time is apt to be shortened by any means whatsoever, the above mentioned test will prove of value.

MR. EARL B. PHELPS. Do you know the bacterial concentration in the cultures used and how much sensitiveness there was?

MR. LEETE. The first bacteria coming through the machine are detected. Due to this, the concentration of the culture within reasonable limits is not a vital factor. We are able to detect the first organism. Hence the test appears to be very sensitive.

MR. PHELPS. The Dairy and Farm Products Co., of New York, asked Doctor North, of the Public Health Bureau, over a year ago to make certain investigations in connection with rather an extensive study of the subject of Pasteurization. In my connection with the company, I was interested in it also. We studied carefully these methods of testing. The results of those investigations are not exactly the same as those mentioned by the speaker in one or two points. I am anxious to learn the sensitiveness of this test, because in the colors which we finally developed and adopted, we are able to read with the added color strength within 0.1 per cent with certainty,

and if we care for greater refinement, we could read to 0.05 per cent, but it seemed for practical purposes that that was not necessary.

That means that starting at any given moment, the milk entering the holder will, of course, be more or less mixed up and begin to come through the outlet before the full half-hour period. By the test we adopted, we were able to read that minimum time of passage through the tank to 0.1 per cent of the concentration. It is not quite plain from what the speaker said whether his test is more sensitive. That is sensitive enough, I think.

The other point, I think, is even more important, and I feel that there is a serious objection to the method proposed. The tests revealed the fact that the most serious difficulty in disturbing the time relations is not the mechanical disturbance, but that due to the velocity of the entrance and mixing factor. There are several disturbances due to the variations in the incoming milk in the holder. You are all familiar, I am sure, with the tremendous disturbances in the differences of the temperature in a fluid containing a large volume.

In our study of the holders, we found very slight differences in the incoming stream, as low as 1° in the incoming stream of pure milk, which would cause an entire overturn of the entire content of the tank, so a tank of 15 minutes' holding would show by our color test a passage of milk in one and one-half minutes' time.

Mr. ERNEST KELLY (Department of Agriculture). Theoretically the currents set up by differences of temperature would be greater in a hot medium than in a cold medium. For that reason, the holding time would be theoretically less in a hot medium than in a cold medium; so that the test, as used, is liberal, as it probably shows a holding time greater than actually occurs, provided temperature differences are an actual factor.

As to the sensitiveness of the test, it would seem to me that a bacterial organism used in a test is more of a criterion of the passage of bacteria through a tank than would be color, because of the diffusion as mentioned by the author of the paper.

Dr. CHARLES E. NORTH. It seems we ought to consider that the object of all tests of Pasteurization is to determine efficiency or inefficiency. It is conceivable that a Pasteurizer might give a result indicating that it was entirely efficient when tested in cold water. On the other hand, if that same Pasteurizer were tested in hot water it might give a totally different result and prove to be inefficient. If you use an organism which is destroyed by water heated to the temperature used in Pasteurization and such an organism which can be used only in a cold-water test, it is quite obvious that the result of the cold-water test will not give fair indication of the efficiency of the Pasteurizer, and that an organism which passes through a given reaction in cold water because it is still alive is not an organism you can use if you give the test of the Pasteurizer efficiency in hot water. The only method of testing that is parallel with the sort of test indicated under Pasteurizing conditions.

The author of the paper on two occasions stated rather emphatically that the temperature of Pasteurization was only 145° F. in 30 minutes.

The laws passed by States and cities in America and also in Canada will show that there is no single time standard recognized. As a matter of fact, the majority of our larger cities have already written in their milk laws a temperature of 142° F. for 30 minutes. For example, the cities of New York, Philadelphia, Baltimore (I could mention 16 other large cities of America) have adopted 142° F. for 30 minutes. There are 15 cities which have adopted 145° F. for a period of time ranging from 10 to 30 minutes, so a uniform standard has not yet been accepted.

I might say that one of the objects Professor Phelps referred to was to find out the margin under commercial conditions, and whether it was possible to reach a final conclusion as to a single time and temperature standard that would allow a margin of safety, and at the same time not injure the commercial value of milk as a commodity.

Mr. LEETE. The Pasteurization temperature of the United States Department of Agriculture is 145° F. for 30 minutes.

Chairman CHERRY. The next paper will deal very largely with this subject. I am going to suggest we proceed with this paper and defer discussion until it has been read. It will be presented by Mr. S. M. Heulings, consulting dairy engineer, and the title is, "Holding tanks for the milk Pasteurizing process." [Applause.]

HOLDING TANKS FOR THE MILK PASTEURIZING PROCESS.

SAMUEL M. HEULINGS, dairy engineer, New York City.

The process of Pasteurizing milk is under no circumstances to be considered as a remedy to counteract the effect of insanitary conditions of the stable, the milk house, or plant, or of any insanitary method whatever of handling the milk from the cow to the consumer. Neither should the effectiveness of the Pasteurization be impaired in an effort to inflate the apparent volume of cream in the bottle of milk.

The fact that there are commercial advantages in the prolonged keeping time of Pasteurized milk is a valuable but secondary consideration.

The United States Public Health Service, the British Ministry of Health, the Dairy Division of the United States Department of Agriculture, the National Commission on Milk Standards, the committee of the sanitary engineering section of the American Public Health Association, and many experienced scientists of unquestioned ability in the dairy field have defined the Pasteurization of milk as having the following elements:

1. Heating to not below 145° F.
2. Holding at not below 145° F. for not less than 30 minutes.
3. Cooling to 50° F., or below, promptly after holding period.

This paper relates to holding tanks only, and particularly to those used in large milk plants. The means of heating and cooling the milk will not be referred to in this discussion.

The second element, holding, demands that all of the milk must be held by an applied treatment, at a temperature of not less than 145° F., for a time period of not less than 30 minutes, if the disease-

producing microorganisms that may infect the milk are to be destroyed.

The rapid growth of the consumption of Pasteurized milk has led to the development of several types of apparatus and to various heat treatments. So long as their use lengthened the keeping quality of the milk, or inflated the apparent volume of cream in the bottle, those engaged in the manufacture of such apparatus, and many of those using them, considered these Pasteurizers and heat treatments as producing all the important results.

With the increase of Pasteurized milk consumption, scientific research has also gone deeper and deeper into milk problems to determine the treatment essential in commercial Pasteurization and to protect the public health. This research work and the engineering investigations that have accompanied it have disclosed many dangerous defects inherent in a large proportion of the apparatus and machinery used for applying a heat treatment to the milk.

The fact that no particular epidemic is pointed out as having been caused by milk treated by this or that apparatus—regardless of its defects—or by a heat treatment below the temperature of Pasteurization, does not justify, in view of the authoritative statements issued by many scientists and scientific institutions interested primarily in the public health, the continued use of such apparatus or such heat treatment which may expose the public to individual sickness or to an epidemic.

All tanks, single or in series, or other apparatus, through which the milk passes in a continuous flow, are often termed "holders." They are not holders, but are retarders that effect a shorter or longer time treatment to milk, but do not effect any assured, predetermined time period of holding even under the best of practical operating conditions.

In continuous-flow retarders, the time of retarding depends almost entirely upon the volume of the flow of the milk passing through. There is no practical way to meter milk; the physical conditions of the milk render this impossible. Therefore, the only gauges of the volume of the milk flowing per minute are the hand valve or milk cock in the milk supply pipe, the milk pump, or the milk flow controller. The hand valve or milk cock is set by guess, with all the uncertainty of guesswork.

The milk pump, piston type, operated by steam, electricity, or belt driven, has a variable discharge of milk, caused by the slippage, air in the milk, or the speed. This latter is the greatest factor of variability. In a practical operating milk plant, the same number of strokes per minute of a pump does not always discharge the same volume of milk. The speed of the pump will vary as the steam pressure, or the electric current, or the shaft speed. Centrifugal pumps have a very erratic discharge and can not be controlled to deliver any predetermined volume per time period.

In addition to the variation of the milk flow, when operated under the best conditions, there must be taken into consideration the opportunity for the unscrupulous operator to speed up the flow, particularly on Sundays or a holiday, or the plant owner who wants a flexible Pasteurizer to speed up the flow to cut down the over-

time. In a continuous-flow retarder there are no possible data or records of the holding time of milk by which the health authorities can determine the treatments actually received by the milk passing through, or that which has already passed through.

In addition to the foregoing—which applies to all types of continuous-flow retarders—the vertical type of flow retarder, regardless of whether the milk flows up or down, is subject to a possible diffusion of bacteria. Regardless of the speed of the flow, this would result in the passing of such diffused bacteria from the tank. The diffusion of bacteria was discovered by experiments of the Dairy Division of the United States Department of Agriculture, in some of which I had an opportunity to participate. A study of the results satisfied me of the uncertainty of the, then called, “continuous-flow holders,” and in July, 1922, I withdrew my approval of this apparatus in New York and London, notwithstanding that the apparatus I had been operating had a factor of safety of 100 per cent, and no coli had ever been discovered in the milk discharged therefrom.

Any milk tank or vat used for milk during the holding period that has its discharge or drainage outlet so connected as to form a pocket extending beyond the body of the hot milk, and does not have an efficient means of maintaining the temperature of the milk in this pocket does not apply the Pasteurizing treatment to the milk therein.

Any tank used for holding milk during the holding period which is dependent on a milk valve or milk cock to prevent the milk that has been heated but not held, from running into this tank: or any tank which is dependent on a milk valve or cock to prevent the milk which is held in the tank from running to the cooler, either by gravity or pump suction, is inherently dangerous, if the raw milk being treated is infectious.

No milk valve or milk cock is safe against leakage. The variations in the ground-joint parts, incident to the expansion and contraction due to temperature changes, a bruise caused inadvertently in cleaning, a thread, a bristle or other foreign matter between the ground-joint parts, will often cause a leak in a milk valve or milk cock that has been apparently tight for months. Fine glass or other cutting substance that may happen to get in between the ground-joint parts will often cut and start a seepage leak. As this leakage can be detected only after it happens, it is obvious that leaky valves or milk cocks permit inefficiently treated milk to leak through, and if this milk is infectious it contaminates the finished product.

There is a milk plant in this country which has a great reputation for safe milk and which has been used extensively by the manufacturers of its alleged holding vats as advertising propaganda in this country and abroad. An engineer, a State official, told me that he saw in this milk plant a stream of milk that had not been even heated to the Pasteurizing temperature, leaking through the discharge cock from this alleged heating and holding vat, and running down with milk which came from another tank, over the cooler.

I have received information which I believe is credible, of many other similar occurrences of leaking valves. Such conditions endanger the consumer, and yet the manufacture and use of such tanks with such valves and pockets continue regardless of the danger to the public health.

No tank is an efficient holding tank, if it does not provide some means, such as a water jacket, for the circulation of water, at such temperatures as will heat the whole tank to the Pasteurizing temperature before the first milk flows in at the beginning of the plant operation. The construction should also be such as to maintain the heat of the tank during a shutdown in course of operation and to prevent any foam that may gather on top of the milk from dropping in temperature.

Any milk valves or milk cocks of the ordinary type, or of the multiple port type, are liable to leakage; therefore, dependence on any such valve or cock to prevent the seepage of milk from one part of the Pasteurizing apparatus to another part is obviously a menace to public health, if the raw milk is infectious.

In tanks or vats in which the milk supplied and discharged is controlled by hand valves or cocks, and in which the bulb of the temperature-recording instrument is often placed nearer the bottom of the tank than at the milk surface, the recorded time of holding the milk is not the shortest elapsed time that all of the milk is actually held. The time, on the time and temperature chart, includes that time required for the milk to discharge until below the temperature bulb and is only another guess as to the shortest time to which all of the milk must have been subjected.

Taking into consideration the great variation in the operation of many types of Pasteurizing apparatus, often unintentionally and uncontrollably on the part of the operator, any test is valueless, except for the particular conditions existing during the period of that particular investigation. Such tests would have no significance for any other operation, and have no bearing whatsoever on the elimination of pathogens from consumer's milk treated by such apparatus in the regular course of plant operation.

The utilization of dyes to determine the minimum time to which milk must actually be held in alleged holders is of value only as indicating inefficiency. The fact that the construction of the alleged holder is such as to raise a question as to efficiency and indicate the need of a test to determine its net holding time, condemns such alleged holders regardless of test.

The application of the holding treatment to milk is the engineer's problem. It does not require any expert engineering to ascertain that milk valves and cocks, when operating under milk plant conditions, are subject to leakage, causing short circuiting of the milk; that if the temperature of the alleged holders drops below the Pasteurizing temperature, the milk will not be held up to that temperature; that the same conditions apply to the temperature of the foam on the surface of the milk; and that variations in the flow through continuous alleged holders cause variations in the time period of holding. Therefore, it is a useless waste of scientific effort, money, and time to endeavor to determine the germ-killing power of any Pasteurizing apparatus having inherent defects in its construction

and subject to unknown or uncontrolled variation of operation, by testing with milk infected with pathogenic bacteria and examining the treated product to determine to what extent the pathogens have been eliminated. That is true at least in so far as it affects the public health in the continued use of such apparatus.

It is reasonable to presume, in this progressive age of the dairy industry, that the manufacturers of alleged holding devices which are inefficient, owing to their defective construction, or unreliable in their operation will change the type of such apparatus, and not compel the milk distributor to employ a technical expert in order to protect himself.

The manufacturer of holding apparatus is responsible to the public for the efficiency of the construction of such apparatus and can not avoid this responsibility by passing it on to the purchaser who, in a large majority of cases, knows nothing whatever about the technical problems involved.

I think that many of the manufacturers of Pasteurizing equipment will soon develop holding apparatus that is safe beyond question for the public health, and they will refuse to make or sell any other type.

The object of this paper is to make an appeal for the protection of the public health. It is not intended to be destructive but constructive for the future. This problem is not a complex one, as I know, for I have worked out a device that is safe; I think it reasonable to suppose that many ways of accomplishing this result, if not already worked out, will soon be found.

Chairman CHERRY. Do you wish to discuss this paper?

Mr. CHAS. H. KILBOURNE (New York). I have been connected with the International Association of Dairy and Milk Inspectors and have been a member of the committee on Pasteurization for some years. The chairman of the committee has gone into it very carefully, and the committee as a whole has recommended that a temperature of 142° F. for 30 minutes be the standard recommendation for this association.

Mr. KELLY. As I recollect, the recommendation was 145° F., never less than 142° F.

Mr. RALPH E. IRWIN (Harrisburg, Pa.). I also am a member of the International Association of Dairy and Milk Inspectors, and wish to correct the statement made by Mr. Kilbourne. There was disagreement among the committee as to the report as given at the Washington meeting and the resolution which was adopted.

Chairman CHERRY. We have one more paper on our program, "Machine milking in New Zealand," by A. B. Robertson, of Auckland, New Zealand. Since the author is not present, this paper also will be read by title.

(Adjournment.)

(Papers read by title):

STANDARDIZATION.

S. J. VAN KUREN, factory sales manager, J. G. Cherry Co., Cedar Rapids, Iowa.

In any country, be it old or new, in the development of that vitally indispensable division of modern agriculture known as the dairy industry, standardization of manufacturing, marketing methods, utensils, materials, package, dairy machinery, equipment, and supplies is a subject of vast importance and magnitude to which, until very recently, little or no thought has been given.

The natural desire for commercial publicity, the popularizing of a brand of goods we make, a label we may have copyrighted, or a design we may have adopted, and the desire to establish a degree of individuality, prompts us all to devise something different from that already on the market, and spurs us on in an effort to create a demand for our particular product in its individual size, style, brand, label, or design.

The inevitable effect of this condition, if allowed to continue without restraint of any kind, is a great economic waste. It is a burden in the cost of operation which must be absorbed by the ultimate consumer, and as a consequence creates a retroactive effect upon the industry concerned.

It adds an obstacle, a decided handicap, to commercial progress, to the successful growth and welfare of industry, and especially any enterprise struggling in its infancy or its early stages of development.

This problem came into the spotlight of national economic observation during the war. The Secretary of Commerce ordered an investigation into the production of commodities where waste of material and labor and duplication of effort were most apparent. Some rather remarkable results followed.

For illustration: The manufacturers of paving brick were marketing 66 sizes of brick, all for the same purpose. A committee from the Department of Commerce was appointed to confer with representatives from the various manufacturing and trade associations, and the result was the elimination of 55 out of the 66 sizes, leaving 11 standard dimensions and sizes of paving brick, which have fully and satisfactorily supplied the market demands ever since, and will continue to do so at a greatly reduced cost in production and therefore a material saving all around.

Another illustration is the malleable chain. Its development during a 50-year period of manufacture demonstrated clearly the waste that follows manufacturing growth and expansion without proper guidance and economic management. Malleable chains used on agricultural implements, farm equipment, conveyors, etc., representing a great diversity of application, naturally developed a great multiplicity of designs, some of them differing but slightly. As a matter of fact, the development of design was greatly overdone. Most purchasers wanted something special, something to gratify a personal idea, which in a majority of instances was purely a whim.

The standardization of an assortment of designs necessary to cover reasonable requirements was first adopted as stock items, followed

by an additional list to cover the necessities of those using designs already well established, but to be made up on order only.

This plan proved a huge success by providing for economical production and the benefit of reduced cost and consequently lower selling prices to those who adopt the standard stock designs, as well as insuring prompt deliveries. Naturally, the purchase of stock items is greatly encouraged. As the result of malleable chain standardization, one manufacturer, who has been listing 2,044 items, reduced his list to 820, a 60 per cent reduction. Some manufacturers made a reduction as high as 75 per cent.

A letter from the United States Chamber of Commerce, dated December 12th, 1921, addressed to W. L. Cherry, says, in part:

Your favor of the 9th received, and you picture a situation which obtains in many lines; and if it is permitted to grow worse instead of better, simply means converting factories into small shops, in which event certain producers who realize this danger and equip themselves for doing business on the right lines will naturally absorb the business of the others. Eliminating the unprofitable and establishing your standards and adhering to them, requires a great deal of backbone in these times, and it is not quite so easy as cooperating with others in the same line and making eliminations by agreement. If your line has an association, an effort of this kind is best conducted by that organization.

I think most manufacturers receive many letters from salesmen in the field, each one telling of the wonderful possibilities in his particular territory for the sale of his specialties, providing the manufacturing department will "just listen to reason" and make certain changes. The salesman has not fully realized the care and thought already given to production of the items in question, nor is it his fault, because it is up to the factory or sales manager, or both, to educate him. The great trouble is competition. The other fellow will promise his customer these special features, and your man is afraid his prestige and that of his firm will suffer if he refuses or even hesitates. The manufacturer must convince the salesman that his job is to sell the goods his employer makes rather than to sell his ideas to the manufacturing department.

The above is not to be construed for a single moment to mean that we want to discourage or that we do not appreciate suggestions from the field. That would be suicidal on the part of any manufacturer. We must have suggestions and ideas. They are of the greatest importance, and nothing must be said or done that will in the least measure discourage our friends and customers from turning them in, but we must learn to differentiate between the practical ideas that represent improvement in a standardized product and those unintentionally calculated to create new styles and designs and thereby increase the number that has already reached a terrifying magnitude.

In advertising, we get most out of our investment if we standardize our selling points, and to do that we must standardize our manufactured products. A multiplicity of lines greatly lessens the power of advertising. Successful advertising consists of repeatedly telling the truth about the advantages and general merit of our manufactured products, but if we continually change our designs and develop our manufacturing plant into a job shop, building to order most of the time and catering to the notions and whims of the

trade, we shall accomplish just about as much as the hunter who shoots blindly into the flock, rather than picking the individual bird as a target.

In our own industry these conditions are not quite so apparent to the public view. Due to the unselfish effort of generous broad-minded men of wide vision and great ideals, the growth of the dairy industry in our country has been phenomenal during recent years, and the expansion of individual ideas has loaded upon the manufacturer and distributor of dairy products such a multiplicity of methods, market packages, sizes, types, styles, and designs that manufacturing cost in every branch and every department of the industry has advanced to a marked degree. Plant operation is seriously handicapped, deliveries are hampered, careless workmanship and manufacturing methods are unconsciously encouraged, and material stocks are of necessity hugely increased. The first step toward a correction of this evil in our industry was a movement on the part of the International Milk Dealers Association, who brought the matter to the attention of machinery and utensil manufacturers through an invitation to a conference between the committees appointed by that association and a committee of machinery men.

They opened the matter for consideration by taking as their first subject the standardization of sanitary fittings. It is a deplorable fact that in this country we have in use at the present time two sizes of sanitary tubing: That which is termed ID type (inside diameter) and OD type (outside diameter). In addition to this, we have a multiplicity of sanitary threads which brings about a complication which you can readily appreciate. A mixing of parts in a plant when the sanitary fitting lines are taken down to be cleaned results in confusion, annoyance, delay and is, to say the least, exasperating and discouraging to the user.

Illustrations of this expensive and unnecessary variation of design in the manufacture of equipment and supplies for the dairy industry are plentiful. First, we will mention butter packages. Our standard bulk package in the United States to-day is the larger size of tub; but who can say whether a standard tub is 60 or 63 pounds, and why should we be manufacturing two sizes with a difference of only 3 pounds in capacity? Butter prints, or, more properly speaking, bricks, are made in varying weights from a quarter pound to 2 pounds each, and there are a great many different dimensions of quarters, halves, 1-pound, and 2-pound bricks.

This materially affects the manufacturers of parchment paper, wrappers, box and tub liners, cartons, packing, storing, and shipping boxes, and every kind of butter-cutting machine.

Manufacturers of parchment paper are compelled to carry on hand in very large quantities a great multiplicity of sizes of parchment paper for wrapping butter packages. On the Pacific coast a sheet 9 by 10 inches is used in wrapping a 1-pound print. In the Middle West and the East, paper 8 by 11 inches is the standard for the same size brick; 9 by 12 inch paper is used to a considerable extent throughout the entire territory, and in some of the New England States a square flat print is made which requires a sheet $8\frac{1}{2}$ by 9 inches or 13 inches. A quarter-pound print of the East and Middle

West requires a sheet $5\frac{1}{2}$ by $6\frac{1}{2}$ inches. The quarter-pound print of the Pacific coast requires a sheet 5 by $6\frac{1}{2}$ inches.

One jobber of dairy supplies reported to us some time ago that they carry in stock 27 sizes of parchment-paper wrappers and liners manufactured by one concern.

It is needless to go into details regarding the effect of these various sizes on the manufacturers of cartons, boxes, tubs, etc. It will be seen from the above illustration the extent to which this condition affects the dairy industry in its various branches.

Milk cans and milk-can covers represent another deplorable situation. Manufacturers appear to rival each other in their effort to produce something that will conform to the whims of possible customers, and thereby increase the number of irregular sizes of milk cans and covers. A manufacturer can not hope to monopolize a certain clientele and conduct his business indefinitely on that basis. The sale of milk cans as well as other dairy equipment and supplies is subject to competition, and when a milk dealer has in his plant one style and size of can and cover and makes a purchase of an additional supply from some other manufacturer he must link his can covers on, oftentimes build a different wagon rack to accommodate a specified number of cans, and in every way subject himself to annoyance, discomfort, irritation, and added expense.

The Dairy Record, of St. Paul, under date of June 7, 1922, quotes from a milk plant letter issued by the United States Dairy Division as follows:

A great deal of progress has been made in the development of milk-plant machinery and equipment in the last 10 or 15 years. Has this development kept pace with the development of the milk business, and has it been wholly along the right lines? There is as yet a considerable lack of standardization in milk-plant equipment. Sanitary pipe and fittings made by different manufacturers are often not interchangeable—although we find steam, water, and gas pipe and fittings of standardized size and design the world over. Tubular milk coolers put out by different manufacturers are not standardized. Milk bottles are more nearly uniform, but even these vary in height, size, dimensions, and cap seat. There is a great variety of types and sizes of milk cans in use, although there has been a tendency toward a can of standard size and type in recent years.

There is no good excuse for milk-plant equipment not being standardized as well as other lines of equipment. As early as 1904, the National Wagon Manufacturers' Association took up the standardization of wagons as to height of wheels, type of tires, etc. The manufacturers of milk-plant machinery and supplies should be encouraged to produce standardized equipment.

There is a standing committee on standardization of equipment in the International Milk Dealers Association, and no doubt much will be accomplished along this line in the near future.

To my mind, the most conspicuous illustration of this unfortunate condition at the present time can be found in our own manufacturing plant, as described and illustrated between the covers of our machinery catalogue, pamphlets, bulletins, etc.

In an effort to supply the trade with its requirements and compete with similar sizes on the market, until about two to three years ago we were building 13 different sizes of churns. Without consulting other manufacturers, we decided to remedy that condition in connection with our churn manufacture, and we reduced the 13 sizes to 6. We now have too many, and are seriously contemplating further reduction in sizes.

We are manufacturing in quite considerable quantities various types of coil machines, Pasteurizers, ripeners, mixers, buttermilk machines, condensed milk coolers, fore-warmers and the like, and I met with one of the greatest surprises of my life when I undertook to figure out how many combinations of coil machines are possible from our regular advertised line. By this I mean how many machines we could build and have each one vary in some particular from all of the others. I don't know how many there are. When I got the figures into four columns I became skeptical. When I got up to over 16,000 I knew there must be something wrong and I quit figuring, and went back to the beginning to check the matter over, only to come back to where I left off with the realization that I had left out some combinations, and the end was not yet. That may sound like a joke. I doubt if you will believe me, but come around to my room some evening, give me 15 minutes and I'll prove to you it's a fact. We make only a few hundred standard types of machines in general construction, but have added from time to time various slight changes in features, fixtures, additional parts, etc., to accommodate the constantly changing notions and whims of the trade, each and every one of which, multiplied by the various regular sizes, styles, and types of machines, keep adding to the thousands of possibilities, until we can figure close to 20,000 possible combinations with no two exactly alike.

My space on this program is limited, and I feel there is no necessity of going into further detail illustrating the conditions existing in the United States to-day as affecting the standardization of manufactured equipment and supplies, the results of which increase our inventory and consequently our investment; decrease efficiency in every department of manufacturing organizations; cause slower turnover, make it impossible to build stock against future orders, therefore delaying deliveries; convert our manufacturing plant into a job-machine shop; interfere with the successful training of skilled experts upon standard work; greatly increase our manufacturing cost, our overhead, the cost of doing business, and therefore, materially affect the price to the consumer.

Another illustration in dairy-equipment manufacture is the tubular cooler. We list as standard product about 205 sizes of tubular coolers, ranging in capacity from around 500 pounds to possibly 12,000 pounds per hour. A great many of these coolers vary one from another by, perhaps, only a few inches or a foot in length, or perhaps one or two tubes. There are various manufacturers of coolers in the United States, and I dare say any one of them will hesitate to reduce the listed sizes of coolers to a reasonable number because of his apprehension regarding competition. A customer who can get a 21-tube cooler when a 20 or 24 would answer his purpose just as well, or perhaps better, will turn his back on the manufacturer who refuses to build a 21-tube cooler, and there you are.

In the preparation of ice cream for retail distribution may be found another illustration of the urgent need of intelligent standardization. Each ice-cream manufacturer wants to market a special dimension brick, "Eskimo Pie," individual slice, or bulk package, hardly any two alike, thus multiplying the great number of pails, cartons, wrappers, brick pans, brick cutting, and molding machinery.

The extra mechanical parts and designs necessary to adapt these large and very expensive machines to the production of every freak size and style of marketing package demanded to satisfy the whim of each customer increases the cost of manufacturing to a tremendous figure.

This situation in the dairy industry has reached a serious state and necessitates a coordinated remedial action on our own part. I would emphatically urge any sister nation, where these conditions have not yet developed to a marked degree, to devote serious, careful, thoughtful consideration to the subject. It is much easier to prevent its development than to correct it afterwards.

The remedy, as I see it, for the condition heretofore outlined is coordination among the various branches of the dairy industry in this country where this condition has developed, and between trade associations of the various kinds. If the associations, such as the International Milk Dealers Association, the National Association of Ice Cream Manufacturers, the American Association of Creamery Butter Manufacturers, and others of a similar nature, together with the associations representing the manufacturers and distributors of dairy supplies and equipment, will get together on the right basis, brush the chips off their shoulders when they approach the entrance to the conference room, check their antagonism, suspicion, doubt, and mistrust of each other with their hats and coats, then sit down around the table and talk with each other with the determination in every man's mind to present constructive and not destructive arguments and suggestions, realize that in order to accomplish a thing of this kind that will be beneficial to the whole, a certain spirit of give and take must prevail, we will remedy the condition referred to in our own country.

To those representing the various nations where the dairy industry has not grown to such tremendous proportions as in the United States I would say, fortify yourselves against the development of this undesirable condition in your country as your dairy industry grows. Stick by standardization, insist upon it, regulate by national laws, uniformity of selling and marketing methods, uniformity of styles and sizes of marketing packages, and adhere to a few practical sizes and designs of each type of machine that is developed for use in the handling of dairy products.

MACHINE MILKING IN NEW ZEALAND.

A. B. ROBERTSON, Auckland, New Zealand.

It was only 30 years ago that milking cows by machinery was first attempted in New Zealand; today there are over 12,000 plants in use in the Dominion, and by these, half our milk supply is drawn. The reason is not far to seek and bears out the old adage that "necessity is the mother of invention." A generation ago, the vast wheat fields of the prairie States of America gave birth to the reaper and binder; so in New Zealand, the large dairy herds and their fast increasing numbers, and the growing difficulty of procuring satisfactory labor, together with high ruling wages, have demanded the milking machine and its general adoption in the Dominion.

It was about the year 1892 that the first milking machine trial was made in New Zealand. Following upon this, several makes of machine were imported from time to time, but experiment showed them to be unsatisfactory. The principal fault with the original machines was that they could not be adjusted to milk the cows clean enough, and necessitated so much stripping that the use of the machine showed little if any advantage over milking outright by hand. In 1900, however, an Australian firm imported a Scotch machine which was afterwards tried in New Zealand, and this stands out in the history of milking machines in this Dominion as the first approach to success. Even this, which was a marked improvement on anything previously used, was not altogether suitable for the work until, as the result of patents brought out by an Australian user, its principal weaknesses had been overcome. For several years following, this machine was the only one in use here, and during this time it was much improved by certain inventions.

Progress does not come rapidly and always the old method is tardy in giving way to the new, but despite the fact that the farmers were strongly prejudiced against milking cows by machinery, quite a number of these machines were installed throughout the country. In the majority of cases long trials and thorough demonstrations were necessary in order to prove that the machines were not injurious to the cows. As time went on, other milkers, including two Australian machines came on the market, but these operated for only two or three years, and then disappeared, as they proved inferior to the pioneer machine. Later several machines of domestic manufacture were introduced, all designed by farmers who had used the pioneer machine and thought they could improve on it. In every case these machines were bucket plants—some with double buckets and some with single. The double buckets received the milk from two cows at one time, while the object of the single buckets was to enable each cow's milk to be kept separate for sampling and testing purposes, and eventually the double-bucket plant was forced to give way to the single.

The next advance in the milking machine was evolved in 1909, when a Taranaki district dairy farmer designed the releaser plant, which did away with the buckets and delivered the milk direct from the cow's teats to the separator or receiving cans. This meant a great saving in labor: For example, with a herd of 60 cows, two attendants could do the milking, as compared with three with the bucket plant. This plant also obviated the heavy carrying and lifting of milk, which especially in the case of women, was most desirable. But the releaser plant was not an unqualified success. It was not easily cleaned, and cleanliness is the cardinal point of successful milk supply; neither did it milk as clean as the bucket plant. However, in due time these drawbacks were overcome, and today the releaser plant is general, the bucket system being used in very few instances. The releaser plant is now so constructed that the pipes can be taken down with a minimum of trouble, and the pipes, being manufactured of smooth brass and well tinned, are easily cleaned. The increasing demand for milking machines brought other makes into the New Zealand market; to-day there are

about 20 different machines procurable, many of which have held their favor for a number of years.

All milking machines are operated on the same principle, a vacuum created by a vacuum pump driven by either water wheel, electricity, or an oil engine. The principal difference between the various makes of machines lies in the pulsators and cups. Some pulsators are automatically driven and others mechanically; the mechanical pulsators, on account of their greater reliability, are the more popular. Some makes have only one pulsator for all the sets of cups; others have one pulsator for each set. The latest improvement in mechanical pulsators provides for altering the action to suit each cow while the machine is in operation. Those who have had experience with dairy cows will know their varying temperaments and characteristics, and will recognize the decided benefit of this improvement.

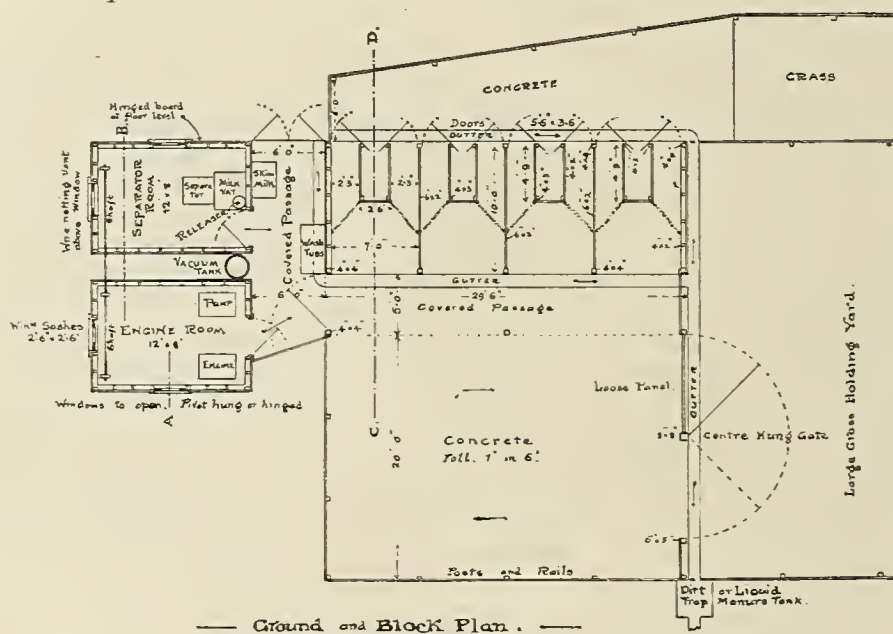


FIG. 1.—Design for run-through milking shed, race, and yards.

The principle of the cups on all machines is the same, each having what is known as "the double wall cup," which has a rubber inflation, inside a metal case. Some cups are constructed with heavy molded inflations; others have plain, small, light tube inflations. These latter are more generally used, as they are more easily cleaned, less costly, and consequently can be replaced more often in event of their becoming contaminated or worn out. Some cups have metal mouthpieces that come in contact with the base of the teat, and others have rubber lips attached to the top of the metal mouthpieces. The latter are more generally used, as they do not fall off and their softness and flexibility tends to greater comfort for the cow with less danger of chafed teats.

The advent of the milking machine demanded in due time a type of milking shed suitable to its installation, and experience taught that what is now known as the "walk-through" shed best suits the demand. Figure 1 is a copy of a plan of cow shed, engine room,

and separator room, as issued by the Dairy Division of the New Zealand Department of Agriculture. This shed is sanitary, efficient, and economical.

Some details of the "walk-through" shed may be interesting. It is constructed with double bail stalls. Each stall is 7 feet wide and has a partition in the center 2 feet 6 inches wide by 4 feet 9 inches deep. The cows stand on either side of the partition and are held there by means of a chain or rope round the hindquarters. At the head of each cow is a door to which a lever is attached, so that when each cow is milked the door can be opened from behind and the cow let out to the pasture, thus enabling quick dispatch. The front of the shed opens onto a small holding yard, and as each cow is released another can quickly be put into position. In time the cows become so accustomed to this order that when one goes out of the door another is waiting to take her place. Each stall has a set of four cups, connected by rubber and metal tubes to the overhead main milk pipe, so that when taken off one cow the cups may immediately be applied to the next. As soon as the cups are removed, each cow is hand stripped (which takes from half to one minute) and turned out. The construction of this shed facilitates handling the maximum number of cows with a minimum of time and labor. Each set of cups milks, on an average, 10 cows per hour; that is to say, a 4-cow plant with two attendants, will milk 40 cows per hour. A greater number of cows could be milked with a 4-cow plant, but it is undesirable that cows should be too long away from their pastures.

Experiment has shown that, other things being equal, and assuming that the machines are kept thoroughly clean and sanitary, machine milk is more sanitary than hand milk, the principal explanation being that a number of usual contaminating factors are removed. The high standard of New Zealand dairy products warrants this assertion, for, as stated previously, 50 per cent of the milk in the Dominion is produced from machine-milked herds.

From time to time investigations have been made with a view to comparing the relative costs of milking by hand and milking by machine, and the following is a summary of a typical case:

Cost of production of milk by machinery on a herd of eighty cows.

	£	s.
Interest, at 7 per cent, on milking plant valued at £250	17	10
Benzine, at 26 shillings per case of 8 gallons	20	14
Lubricating oil, 2 gallons		17
Rubberware and spare parts	5	0
Insurance	1	0
Labor: 3 men, at 35 shillings per week each	189	10
Board for 3 men at £1 per week each	108	0
	342	11
Depreciation on plant, 10 per cent	25	0
	367	11

This estimate is based on a period of nine months, which may be taken as the duration of New Zealand's average milking season, and provides for the cows' being milked in two hours at each milking.

If a separator is used, this can be run in connection with the milking plant, without any extra cost for power, the separator being timed to finish about five minutes after the last cow is milked.

Cost of production of milk by hand on a herd of 80 cows with 6 milkers.

Labor: 6 men, at 35 shillings per week each.....	£360
Board for 6 men, at £1 per week each.....	216
	<hr/> 576

This also is based on a nine months' period. The estimate allows for 6 men, milking 7 cows per hour each, which means they take two hours to milk 80 cows each milking. If a separator were used, extra labor would be required to operate it.

Cost of production of milk by hand on a herd of 80 cows with 3 milkers.

Labor: 3 men, at 35 shillings per week each.....	£180
Board for 3 milkers, at £1 per week each.....	108
	<hr/> 288

This, too, is based on a period of nine months, and allows for 3 milkers, milking 7 cows per hour each, which means they would take four hours to milk 80 cows. If a separator were used, extra labor would be required to operate it.

The average milker can, if necessary, milk by machine 50 cows at one milking, as against the average milker's 12 by hand. This makes the machine operator independent of hired labor.

Before the successful introduction of milking machines, it was the accepted practice for the women and children of the household to participate in the milking of the herds. Since its adoption the presence of women and children in the milking shed has been an exception and unnecessary.

The conditions of labor in New Zealand are such that it would be impracticable to carry on dairying to the same extent as at present, without the assistance of the milking machines, and the high standard of New Zealand products in the world's markets to-day shows that the quality has continuously improved since the introduction of mechanical milking. Needless to say, much of the improvement is due to the knowledge accumulated with experience, and to the greater care exercised since dairying took up its place of importance among the Dominion's primary industries; but there is no doubt that much of the advancement is due to the advent of mechanical milking of dairy cows, and it is doubtful if dairying in this country would otherwise have attained its present prestige. One of the principal reasons for the successful use of mechanical milking in New Zealand has been the keen supervision of the Dairy Division of the Department of Agriculture in connection with the sanitary construction and cleansing of the machines.

The extent and increase in machine milking in New Zealand is shown by the official statistics of the number of milking plants, as follows: 1919, 7,577 plants; 1920, 8,806 plants; 1921, 10,450 plants; and 1922, 12,465 plants.

SESSION 24. CONDENSED MILK AND MILK POWDER.

Honorary chairman. DR. TSANNYOEN PHILIP SZE, Consul General of China, New York, N. Y.

Chairman. WALTER PAGE, production department, Carnation Milk Products Co., Oconomowoc, Wis.

Secretary. C. ELMER WYLIE, head of the department of dairying, University of Tennessee.

Y. W. C. A. ASSEMBLY HALL,

Syracuse, N. Y., Wednesday, October 10, 1923—9.30 a. m.

Chairman PAGE. The meeting will please come to order. I take pleasure in introducing to you, Dr. Tsannyoen Philip Sze, honorary chairman of the meeting this morning.

Doctor SZE. Mr. Chairman, I consider this a great honor to me, to act here this morning as your honorary chairman, on account of the absence of Dr. Otto Rahn. We have not much fresh milk, but I can assure you we use a great deal of condensed milk. I thank you.

Chairman PAGE. The first paper will be "The principal factors affecting the keeping quality of sweetened condensed milk," by A. Miyawaki.

THE PRINCIPAL FACTORS AFFECTING THE KEEPING QUALITY OF SWEETENED CONDENSED MILK.

ATSUSHI MIYAWAKI, Ph. D., professor of dairy and meat technology, Hokkaido Imperial University, Sapporo, Japan.

The manufacture of butter and cheese has been practiced as long as history has been written. Condensed milk, which is now rapidly taking its position among the important products of dairy manufacture, is an invention of the nineteenth century, though Japanese history records the fact that a product resembling present-day condensed milk, but with much less water content, was manufactured as early as the seventh century.

The author has devoted almost seven years to a study of some of the most important problems pertaining to the successful production of condensed milk, and particularly to the factors that influence the keeping qualities of this product. The work has been done in the laboratories of the Hokkaido Imperial University and in a near-by commercial factory.

Early in this study it was found that to solve many problems it was necessary to conduct experiments under factory conditions as well as on a laboratory scale. It was also found that tests of only a few months or a year were not sufficient to reveal the facts in regard to the keeping quality of sweetened condensed milk. Instead, the tests should be made for a long series of years. Since March, 1915, it has been the author's privilege to have the free use of a well-equipped and well-managed condensed-milk factory, and he has manufactured

over 1,400 batches of sweetened condensed milk, using about 8,950,026 pounds of milk and making over 3,956,000 pounds of the finished product. Careful attention was given to each step in the manufacture of condensed milk under commercial conditions; samples were taken from each batch for laboratory tests.

THE DEFECTS OF CONDENSED MILK.

There are many defects in condensed milk, some of which may be detected soon after the milk is condensed; others may be noticed weeks later, and others only after even years have passed. The most common defects of sweetened condensed milk are enumerated by Professor Hunziker, of Purdue University, as follows:

1. Sandy, rough or gritty.
2. Settled.
3. Thickened and cheesy.
4. Lumpy, white, or yellow buttons.
5. Blown and fermented.
6. Rancid.
7. Putrid.
8. Brown.

(a) A rough or gritty consistency and a settled condition (1 and 2) can be detected with the aid of a microscope soon after manufacture or in the course of manufacture.

(b) A blown condition or a putrid state (5 and 7) are due entirely to microorganisms and can be detected within a month or two after manufacture in warm weather, or by incubation almost immediately after manufacture.

(c) A lumpy condition and a rancid state (4 and 6) may be due mostly to the action of microorganisms or to a limited extent by enzymic or mechanical changes.

(d) A thickened cheesy state and a brown color (3 and 8), while previously believed to be due to bacterial fermentation, are now known to be due entirely to aging. When condensed milk is not carefully manufactured, or if poor milk and sugar are used, the thickened state and the brown color soon develop. Milk that has been carefully made of good raw material does not show either of these defects for years after manufacture.

Defects 1 and 2 are very common and can be easily avoided by careful attention during the cooling process. They do not lower the nutritive value of the product. Defects 5 and 7 are rare if enough sugar of good quality is used in the manufacture. Defects 4 and 6 can be avoided easily if care is taken in preheating, subsequent cooling, and canning. Defects 3 and 8 can not be avoided entirely, as all sweetened condensed milk will become both thicker in consistency and deeper in color as it gets older. Some milk thickens in a short time, while other milk may keep fairly well for years. This thickening is the most troublesome of all defects to condensed milk manufacturers. For this reason an effort was made to overcome this difficulty.

BACTERIA IN RELATION TO KEEPING QUALITY.

It is commonly acknowledged that the deterioration of foodstuffs is mostly due to bacterial action. It was this fact perhaps that led the Dairy Science Association of America to adopt a score card for

sweetened condensed milk based largely on the number of bacteria it contained. A study of the relation of keeping quality to bacterial content and growth was made with 18 samples of different brands sold on market. The result shows that the number of bacteria in sweetened condensed milk has no definite relation to its keeping quality. Moreover, while condensed milk changes its consistency more or less upon incubation, the number of bacteria decreases. On the average, the original bacterial content was 49,352 per gram, decreasing upon incubation at 38° C. for a week to 18,169, or less than half the original number. The summary of the result is shown in the following table:

TABLE 1.—*Relation of keeping quality to bacterial content.*

Keeping quality.	Number of samples.	Number of bacteria per gram.		
		Before incubation.	After incubation.	Difference.
Badly thickened.....	3	58,173	66,436	8,263
Thickened.....	4	86,425	25,512	-60,913
Slightly thickened.....	6	43,891	1,126	-42,765
Normal.....	5	21,034	3,784	-17,250

On an average the number of bacteria is increased in badly thickened condensed milk, but in all other groups the number decreases after incubation. When individual samples are taken into consideration, one in the badly thickened group showed a decrease and three in the normal group showed increases. Generally speaking, condensed milk that keeps best contains the least bacteria, yet a careful study of our data does not sustain the old notion that the number of bacteria can be used as the criterion by which to measure the keeping quality of sweetened condensed milk. In fact, we now know that if sweet milk is made properly and of good material there will be no deterioration due to bacterial growth.

A STUDY OF THE PHYSICAL CHANGES IN CONDENSED MILK.

While by keeping quality we mean the maintaining of both the chemical and the physical characteristics, at this moment we are chiefly concerned with methods of holding the natural physical condition of condensed milk, for it happens that the chemical constituents may be apparently unaltered while the physical condition changes so much that the consumer declares the product to be putrid.

The most common of all physical changes of condensed milk is in its consistency. Almost all freshly made condensed milk has a sirupy consistency, but poorly made condensed milk soon loses this property and becomes thickened or pasty. This is the greatest trouble encountered by early condensed milk manufacturers. It is not uncommon that apparently well-made condensed milk becomes pasty and unsalable within two or three months. Sometimes thickening goes so far as to make the product cheesy in character.

If the physical quality of condensed milk could be foretold, it would be a great help in maintaining the standards of the product. Unfortunately, mere appearance at the time of manufacture is no sure guide to its keeping qualities, as we have learned from repeated tests.

In order to study the keeping quality, a practice of incubation was begun. For just what reason the incubation method was chosen is not clear, except that when I began my work the view still prevailed that changes in consistency of condensed milk were due to bacterial action, and, therefore, to test the keeping quality of a product the bacteria were encouraged to grow by incubation. It was believed also that by incubation the conditions of a tropical climate, the severest test condensed milk has to meet, was closely approximated. At any rate, this practice of testing condensed milk has been in use for a long time in Japan.

Experience with this test shows that the incubation has some effect on consistency and color. Upon incubation, a poorly made condensed milk soon becomes thickened or pasty and sometimes assumes a brown color. Factors affecting the consistency and color are many, but apparently this change is due primarily to a prolonged application of heat and not to bacterial action, for nearly the same effect can be obtained by applying a very high heat test for a short time. When poorly made condensed milk is subjected to a temperature of 80° C., it thickens within 10 to 15 minutes, assuming about the same consistency as when it is incubated for a week or more.

In view of the fact that a high heat thickens the condensed milk, a considerable number of experiments were made to see the relation of high heat to the incubation method. It was found that there was a certain relation between these two methods of testing for keeping quality. It was also found that the higher the temperature, the shorter the time required for it to thicken. The thickening in both cases is essentially to the same degree. These results support the view that the thickening of condensed milk is due primarily to the heat applied and not to bacterial action. It is also true in case of thickening under natural condition. To be sure, there are cases where the thickening of condensed milk is due entirely to bacterial causes, but in such a case coagulation of casein takes place, instead of the milk getting simply pasty. In such a case, the thickened condensed milk never goes back to its original condition, but a pasty condensed milk caused by heat and aging assumes almost its original consistency again upon being stirred. Since 1911, thousands of incubation tests were made with a great variety of brands of condensed milk but there were only two or three cases where thickening could be attributed to real coagulation. In nearly all cases the thickening was only physical in its nature, hence reversible in character.

If, however, the temperature is too high, the casein of condensed milk changes its nature and coagulates, and the milk never returns to its original consistency. Therefore, without the aid of bacterial action and by heating alone a nonreversible thickening of condensed milk may occur. The opinion that the ordinary thickening of condensed milk in the incubator is not due to bacterial action may also be supported by the study of bacterial flora of condensed milk mentioned in a preceding paragraph.

THE RELATION OF INCUBATION CHANGES TO KEEPING QUALITIES.

In my country it is customary to test condensed milk for its keeping quality by incubation for two to three weeks. Fourteen samples were taken from each batch of condensed milk made. Ten were incubated and four were kept under natural conditions. The incubated samples were tested as to consistency, color, and flavor, weekly for 10 weeks. Samples kept under ordinary conditions were tested at intervals of six months for two years. By this study we were trying to see if there is a relation between the changes due to incubation and the natural changes due to aging, and if the slow aging changes could be hastened by the process of incubation. The data obtained are summarized in Table 2.

TABLE 2.—*The relation of the incubation test to the keeping quality of condensed milk.*

Time within which incubated samples thickened.	Number of samples which thickened under ordinary conditions within different periods of time.				Kept well for 2 years.
	6 months.	1 year.	1.5 years.	2 years.	
1 week.....	6	6	1	.....	.....
2 weeks.....	12	10	1	.....	.....
3 weeks.....	1	6	9	.....	.....
4 weeks.....	.....	4	5	1	.....
5 weeks.....	.....	1	14	4	1
6 weeks.....	1	.....	8	15	4
7 weeks.....	.....	1	5	14	7
8 weeks.....	.....	1	5	20	11
9 weeks.....	.....	.....	1	20	20
10 weeks.....	.....	.....	1	21	91
Kept well for 10 weeks.....	.....	.....	.....	14	239

When we analyze the data in Table 2, we see that there is a rather definite relation in the physical changes due to incubation and to natural aging. In general, it may be said that about three weeks of incubation correspond to about six months of aging under natural conditions. Therefore, if a condensed milk keeps well in an incubator for more than nine weeks it may be expected to keep well about two years on the market. Any condensed milk which does not keep well for three weeks in the incubator is very likely to thicken within six months. Unless a condensed milk keeps well for six weeks, it can not be expected to keep much longer than one year under natural conditions.

RELATION OF BUTTERFAT CONTENT TO KEEPING QUALITY.

A good condensed milk should have good luster and be thick and sirupy in consistency. It should give a long fine stringy drop, and when held against the light it should have a good transparency. In course of manufacture it was observed that the product was much smoother where the fat content was high. A fat-poor product was always lighter in color and lacked in quality. Fat-poor samples also gave a product of rather light dull color—one lacking in transparency when held against the light even though the consistency was apparently dense enough.

In studying the relation of fat content to the keeping quality of condensed milk, samples were kept under natural condition for two years and were tested at intervals of six months. Incubation tests were also run side by side for comparison. Six hundred and ninety-seven samples are involved in this test. Table 3 gives a summary of the results:

TABLE 3.—*Relation of fat content to the keeping quality of condensed milk.*

	Time at end of which samples thickened.				Kept well for 2 years.
	6 months.	1 year.	1.5 years.	2 years.	
Number of samples.....	16	39	69	125	453
Maximum fat test.....	0.60	3.60	3.80	3.70	4.05
Minimum fat test.....	.05	.05	.02	.05	.05
Average fat test.....	.982	1.153	2.501	3.010	3.382

The data indicate that a condensed milk which is made from milk low in fat does not have good keeping quality. To see this relation more clearly, Table 4 is prepared from the original data.

TABLE 4.—*Distribution of samples in various groups of fat content and keeping quality.*

Fat test (per cent).	Thickened at the end of—				Kept well for 2 years.
	6 months.	1 year.	1.5 years.	2 years.	
Under 1.....	10	18	11	2	2
1 to 1.5.....	1	4	7	13	1
1.5 to 2.....	1	7	5	3	4
2 to 2.5.....	1	5	4	7	5
2.5 to 3.....			1	3	3
3 to 3.5.....	2	4	17	64	410
3.5 and up.....	1	1	20	32	28

These data show clearly that the fat content of milk influences the keeping quality of the condensed product. The relation can be more correctly estimated if a percentage distribution of the aging group is prepared with respect to fat content of original milk.

TABLE 5.—*Percentage distribution with respect to fat content.*

Fat test (per cent).	Thickened at the end of—				Kept well for 2 years.
	6 months.	1 year.	1.5 years.	2 years.	
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Under 1.....	62.50	46.15	16.92	1.61	0.44
1 to 1.5.....	6.25	10.26	10.77	10.48	.22
1.5 to 2.....	6.25	17.95	7.69	2.42	.88
2 to 2.5.....	6.25	12.82	6.15	5.64	1.11
2.5 to 3.....			1.54	2.42	.66
3 to 3.5.....	12.50	10.26	26.15	51.61	90.51
3.5 and up.....	6.25	2.53	30.78	25.32	6.15

Looking at the same data from another angle the percentage distribution of samples belonging to the same group of fat content with respect to keeping quality is shown in Table 6.

TABLE 6.—Percentage distribution with respect to keeping quality.

Fat test (per cent).	Thickened at the end of—				Kept well for 2 years.
	6 months.	1 year.	1.5 years.	2 years.	
Under 1.....	23.26	41.86	25.58	4.65	4.65
1 to 1.5.....	3.85	15.39	26.92	50.00	3.85
1.5 to 2.....	5.00	35.00	25.00	15.00	20.00
2 to 2.5.....	4.55	22.73	18.18	31.82	22.72
2.5 to 3.....			14.28	42.86	42.86
3 to 3.5.....	.40	.81	3.42	12.88	82.49
3.5 and up.....	1.22	1.22	24.39	39.02	34.15

If all the samples are arranged in two groups according to the richness of milk, the group testing less than 3 per cent butterfat showed a high percentage of spoilage before 18 months, while the group testing more than 3 per cent presented much the greater percentage of samples which kept well for two years or more. This is shown in Table 7.

TABLE 7.—Percentage distribution of high and low fat content with respect to keeping quality.

Fat test (per cent).	Thickened at the end of—				Kept well for 2 years.
	6 months.	1 year.	1.5 years.	2 years.	
Under 3.....	11.02	28.81	23.73	23.73	12.71
More than 3.....	.52	.86	6.39	16.58	75.65

From what has been discussed, it may be seen that the percentage of butterfat in milk for condensing plays an important part in the keeping quality of the product. Butterfat seems to give to condensed milk a smooth fluid consistency, while casein has the tendency to set. The thickening of condensed milk is, in most cases, a setting phenomenon due to the casein in it. This setting action is hindered by the presence of butterfat. It is essential, therefore, that milk for condensing should have a good percentage of fat to insure a high keeping quality.

RELATION OF ADDED SUGAR TO KEEPING QUALITY.

Sucrose plays an important part in manufacture of sweetened condensed milk. The keeping quality of such milk is to a great extent dependent on the amount of sucrose added. Without sucrose, the milk will not keep more than a few days unless it is otherwise preserved. It is, therefore, important to see the influence of the amount of sucrose added, to the keeping quality.

Five hundred and seven batches of condensed milk whose manufacturing records, together with the incubation and aging tests, are

all complete, are selected to show how the keeping quality is influenced by the amount of sucrose added. The results are summarized as follows:

TABLE 8.—*The relation of the percentage of added sugar to the keeping quality.*

Average percentage of added sugar.	Kept in incubator.	Keeping quality stood aging well.
	<i>Average weeks.</i>	<i>Average years.</i>
12.46	1.33	0.50
13.48	1.95	.61
14.41	6.33	1.30
15.19	7.32	1.34
15.62	8.05	1.66
16.00	9.24	1.78
16.33	8.75	1.79
17.13	9.75	2.00
18.28	10.00	2.00

The keeping quality apparently increased with increased rate of sugar added to the fresh milk. To insure a good keeping quality, it is necessary to use more than 15 per cent of sugar by weight of fresh whole milk.

In course of manufacturing it was found that the degree of vacuum in the pan has some influence on the keeping quality, a high vacuum having a good influence on the keeping quality of the finished product. It is wise, therefore, to keep the vacuum in the pan always higher than 26 inches. The rapidity with which a unit amount of milk is condensed also has a great influence on the keeping quality. In order to manufacture a good-keeping condensed milk it is very essential to evaporate at a rapid rate.

CONCLUSIONS.

In conclusion, it may be said that: (a) The deterioration of sweetened condensed milk may be due either to bacterial or physical changes or aging. Thickening is by far the most common and troublesome form, particularly for beginners in the manufacture of sweetened condensed milk. (b) When the thickening is due to aging it is readily corrected by stirring; when due to bacterial fermentation it is irreversible. Thickening can be avoided in large measure by observing the following precautions:

1. Milk to be used for condensing should contain more than 3 per cent butter fat.
2. The rate of sugar to be added should be more than 15 per cent by the weight of whole milk.
3. The vacuum of pan should be maintained at higher than 26 inches.
4. The condensing should be accomplished as rapidly as possible at less than 25 minutes per 1,000 pounds of fresh milk.

Chairman PAGE. The next paper is "The heat coagulation of milk," by Doctor Sommer.

THE HEAT COAGULATION OF MILK.

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In the sterilizing process used in the manufacture of evaporated milk it is desirable to produce an incipient coagulation in the nature of a tender jell, or "liver," as it is known in the industry. This coagulum should be of such a quality that when it is broken up by the shaking process it produces a product of a homogeneous creamy body. The creamy body is desirable not only because of the rich appearance, but also because it prevents the separation of the butter fat.

However, not all evaporated milk is alike in the readiness with which it coagulates. At times the milk requires such a severe heat treatment to produce a coagulum that the color becomes very dark and undesirable; at other times the milk coagulates so readily that it would be unmarketable on account of its curdy appearance if it were heated long enough to preserve it. The latter of these two difficulties is most prevalent and troublesome, and constitutes the problem with which we are concerned in this paper.

This troublesome heat coagulation was encountered as one of the problems early in the development of the evaporated-milk industry. It was then assumed that it is due to a high acidity, and efforts were made to overcome the difficulty by neutralizing. In some cases lime was used to neutralize, but the results were disastrous for reasons we shall discuss later. Sodium bicarbonate was then used with better success. Since then the use of sodium bicarbonate has become an accepted practice for alleviating the troublesome heat coagulation, but there are still many cases where its use does not remedy the difficulty.

Because the heat coagulation of the milk is a matter of daily concern, the manufacturers of evaporated milk have observed the practices that affect it. Thus it has been observed—

1. That the troublesome heat coagulation is most prevalent during the fall, winter, and early spring.
2. That there is a sudden improvement when the cows go on pasture in the spring.
3. That the careful grading of the milk is not a remedy for the trouble.
4. That high forewarming temperatures before the milk is concentrated reduces the coagulation.

On the basis of these and other observations, many conflicting ideas and theories have been projected. The result is that our knowledge on this subject is in a chaotic condition. Experimental work on this problem was therefore undertaken.

On account of the large amount of routine work necessary in studying the coagulation of concentrated milk, the plan that was followed was, first, to study the heat coagulation of fresh, unconcentrated milk at high temperatures to determine the factors that affect it, and, second, to apply our knowledge of these factors to concentrated milk.

In studying the heat coagulation of fresh milk, the samples of milk were heated to a temperature of 136° C. At first this was

done in an autoclave, but this was soon replaced by a xylol vapor bath in which the milk was heated in sealed glass tubes. The milk was sealed into 7-millimeter glass tubing about 5 centimeters long. These tubes were mounted in a rack and suspended in the boiling xylol vapors in such a manner that the tubes could be tilted from end to end. The coagulation was recorded as the time required for the first visible coagulum to appear as the tubes were tilted. It was soon found that fresh milk samples differ widely in heat coagulation.

TITRATABLE ACIDITY.

Since the general use of sodium bicarbonate implies the assumption that the coagulation is due to the acidity of the milk, the first factor that was studied was the titratable acidity of the milk. Observations were made on the titratable acidity and the heat coagulation of 86 samples of milk from 31 different cows of the university herd. The titratable acidity of these fresh milk samples ranged from 0.10 to 0.26 per cent expressed as per cent of lactic acid. Of the 86 samples, 45 had an acidity of over 0.18 per cent. There was no consistent relation between acidity and coagulation; about the same percentage of samples coagulated above 0.18 per cent acid as below that acidity. It so happened that the sample of the lowest acidity coagulated in $1\frac{1}{2}$ minutes, and the highest in acidity did not coagulate in 20 minutes. From this we conclude that titratable acidity is not the determining factor in the heat coagulation of fresh milk.

HYDROGEN ION CONCENTRATION.

It was then thought that there might be some relation between the heat coagulation and the true acidity or hydrogen ion concentration. In a study of 37 samples the hydrogen ion concentration varied from pH 6.25 to 6.97.

The average pH of the 23 samples that coagulated in 20 minutes at 136° C. was 6.71, while that of the 14 samples that did not coagulate was 6.66. This average difference is so slight, and there was such a total lack of any consistent relation between the coagulation of the individual sample and their hydrogen ion concentration, that we can conclude that the reaction of the milk is not the determining factor.

CONCENTRATION.

In an effort to account for the wide differences that were observed in the heat coagulation, the concentration was studied. It was found that the coagulation could be prevented by diluting coagulating samples with slightly over 10 per cent of distilled water. It was further found that dilution with water had a greater effect than diluting with the filtrate of the same milk sample through a Pasteur-Chamberlain filter. Therefore the concentration of the milk serum also has an effect on the heat coagulation. While the concentration of both the casein and the serum are factors in the coagulation, they fail to account for the wide differences in coagulation in samples that are alike or nearly alike in concentration.

COMPOSITION AND BALANCE OF MILK SALTS.

The observation that the concentration of the milk serum has an effect on the coagulation indicates, after titratable acidity and hydrogen ion concentration have been eliminated from consideration, that the soluble milk salts have an effect on the coagulation. This possibility is strengthened by the knowledge that in general electrolytes have a marked effect upon the stability of colloids. Since the bivalent and trivalent ions have the greatest effect upon colloids, our attention was turned to the calcium, magnesium, and citrates, and phosphates in the milk.

By adding these salts in a soluble form to the milk, it was soon found that they have a pronounced effect upon the heat coagulation. It was found that the addition of soluble calcium and magnesium salts equivalent to an increase of 0.01 per cent in the CaO or MgO content of the milk changed a noncoagulating milk sample to one that coagulated very readily on heating. Such a sample could then be taken, and by adding an equivalent amount of sodium citrate or di-sodium phosphate, again changed to a noncoagulating sample. In other words, it was found that the effect of the calcium and magnesium is the direct opposite of the effect of the citrates and phosphates.

A noncoagulating sample can also be caused to coagulate in the heat test by the addition of citrates and phosphates; and can again be changed to a noncoagulating sample by the addition of the proper amount of soluble calcium or magnesium. Thus it is evident that the coagulation can be caused by an excess of either calcium and magnesium or citrates and phosphates. The samples in which these two classes of salts are in the proper balance do not coagulate in the heat test. The samples that coagulate can be changed to noncoagulating samples by the addition of the proper salt.

During a period of four years a large number of samples of fresh milk have been studied that coagulated in the heat test. Some of these samples required the addition of calcium or magnesium to prevent the coagulation, others required the addition of citrates or phosphates. In all cases it was possible to prevent the coagulation by the addition of either one or the other of these two classes of salts. In no case was more than the equivalent of 0.023 per cent CaO, 0.016 per cent MgO, 0.077 per cent citric acid, 0.029 per cent P_2O_5 added, and in most cases only one-fourth or one-half of these amounts were required.

The fact that these normal milk salts affect the coagulation in such small amounts, in amounts well within the limits of the normal variation of these salts in the milk, forces the conclusion that the heat coagulation of fresh milk is determined mainly by the composition and balance of the milk salts. This conclusion was further verified analytically by comparing the calcium, magnesium, citrate, and phosphate content of 30 samples of milk with their heat coagulation.

EVAPORATED MILK.

The demonstration that the milk salts have a decided effect upon the stability of the casein in fresh milk is quite conclusive. This logically leads to the conclusion that they must have a similar effect.

on the evaporated milk, for we are here dealing with a system that is entirely similar, modified only to the extent to which it has been concentrated and the heat treatment and other manipulations it has undergone. This was readily demonstrated by the addition of these salts to concentrated milk both on an experimental scale and under commercial conditions.

It was found that the addition of soluble calcium and magnesium salts, and citrates and phosphates in amounts even less than the equivalent of 0.01 per cent CaO or MgO , 0.01 per cent P_2O_5 or 0.03 per cent citric acid, had a pronounced effect on the heat coagulation of evaporated milk.

With these results as a basis, attempts were then made to remedy the troublesome heat coagulation on a commercial scale at a number of condenseries. From the results obtained, it is evident that in no case is the coagulation of evaporated milk due to an excess of citrates and phosphates under natural conditions, for the addition of calcium or magnesium salts in all cases caused an increase rather than an improvement in the coagulation.

However, the addition of di-sodium phosphate or sodium citrate produced very satisfactory results in remedying the troublesome coagulation. In general the addition of from 4 to 10 ounces of the crystalline di-sodium phosphate per 1,000 pounds of evaporated milk changed an unsafe sterilizing process to one that is satisfactory. In exceptional cases as high as 1 pound of di-sodium phosphate was added per 1,000 pounds of evaporated milk, but, on account of the large amount of water of crystallization in the di-sodium phosphate, this represents an increase of only 0.0198 per cent in the P_2O_5 content of the evaporated milk. This addition on the basis of the unconcentrated milk amounts to only 0.0099 per cent, and is negligible when compared with the normal content of P_2O_5 and its normal variation in the milk.

From these results we can conclude that the milk salts are the main factor in determining the heat coagulation of evaporated milk as well as in fresh milk. The remedy, the use of di-sodium phosphate to prevent troublesome heat coagulation, is already in extensive use in the industry.

This conclusion is contrary to the conclusion of Rogers, Deysher, and Evans (1). By comparing the heat coagulation of concentrated milk samples with the excess of calcium and magnesium over citrate and phosphate as determined by analyses and calculations, they concluded that there was no definite relation between the excess of calcium and magnesium and the coagulation. The error of their conclusion can readily be understood when we realize that in their calculations four analytical results are used, and the experimental error in any one of these four analyses is likely to be equivalent to the largest amount of di-sodium phosphate used above. The conclusions based on the effect of the addition of the milk salts are therefore more reliable.

OTHER FACTORS THAT AFFECT THE COAGULATION OF EVAPORATED MILK.

It must not be inferred that the composition of the milk salts is the only factor that needs to be considered; the reaction of the milk, the albumin content, and the presence of rennet-forming organisms are also factors.

The acidity of the milk undoubtedly is a factor in the heat coagulation of evaporated milk; but it is not as important a factor as the extensive use of sodium bicarbonate would indicate, for the effect of the sodium bicarbonate can not be attributed entirely to the neutralization of acidity. By experiments with fresh milk we have found that sodium bicarbonate counteracts the effect of an excess of calcium and magnesium to some extent in a manner similar to citrates and phosphates. Thus in the milder cases of incorrect salt balances in the milk, the sodium bicarbonate may remedy the difficulty, but in the more severe cases citrate or phosphate are more effective.

The importance of the acidity or reaction of the milk as a factor has been especially emphasized by Rogers, Deysher, and Evans (1). They found that by inoculating and incubating a sample of milk for three hours that the acidity changed only slightly, from 0.170 per cent to 0.175 per cent, and the hydrogen ion concentration from pH 6.57 to 6.51, but the coagulating temperature of the concentrated milk as determined by heating for 30 minutes changed from 119° C. to 113° C. They attribute this decided change in the coagulation to the minute change in reaction. They ignore the fact that in the ripening of milk the citric acid is rapidly destroyed. Bosworth and Prucha (2) have shown that in six hours fermentation the citric acid in the milk may be completely destroyed. With the destruction of the citric acid, an excess of calcium becomes available, and it is mainly this excess of calcium that causes the coagulation to take place more readily. To explain the change in coagulation on the basis of the minute increase in acidity alone is placing undue emphasis on the importance of the acidity.

Since albumin itself is a substance that is readily coagulated by heat, it may be expected that an appreciable increase in the albumin content will increase the coagulation. This was verified by experiment. A sample of milk containing 0.67 per cent albumin was divided into two portions; to one of these 0.09 per cent lactalbumin was added. The two portions were then preheated to the boiling point for five minutes, then condensed and standardized to 18 per cent solids not fat. In the pilot sterilizer the control sample coagulated at 245° F. in 20 minutes, while it took only 15 minutes for the sample to which the albumin had been added to coagulate. This demonstrates that the albumin content may be a factor of considerable importance. However, the increase used in the experiment is probably equal to the maximum variation that may be expected in the mixed milk at a condensery, yet it did not decrease the sterilizing process to such a point where it would be troublesome. Thus, it is evident that there must be other factors of equal or greater importance to account for the troublesome coagulation.

Since the albumin content of the milk has an effect upon the coagulation, it seems probable that the effect of preheating is in part due to the precipitation of the albumin. This was demonstrated experimentally by dividing a milk sample into two portions and preheating one portion at 180° F. for five minutes, and the other portion at the boiling point for five minutes. After the milk was concentrated and standardized to 18 per cent solids not fat, samples were analyzed for soluble albumin. The sample preheated to 180° F. contained 0.86 per cent and the boiled sample contained 0.56 per cent

soluble albumin. The former of these two samples coagulated in 20 minutes at 245° F. in the pilot sterilizer, while the latter coagulated in 11 minutes. From this we can conclude that the effect of preheating is largely due to the precipitation of the albumin.

In addition, we may conclude that the preheating process decreases the heat coagulation by precipitating some of the soluble calcium salts. We have no direct proof for this point because the coagulation is sensitive to amounts of the salts that escape detection analytically, but this conclusion must logically follow from the demonstration that the calcium salts affect the coagulation and the demonstrated fact that heating precipitates soluble calcium salts in milk.

The effect of rennet-forming bacteria on the coagulating temperature has been studied by Rogers (3). He found that a sample of milk inoculated with a culture of rennet-forming organism and incubated for three hours had a coagulating temperature of 226° F. after it was concentrated, compared with 240° F. for the uninoculated control sample. This is a large change, but it seems unlikely that the natural conditions should ever be as favorable for these organisms as in this experiment. The rennet-forming organisms usually represent only a small fraction of the bacterial flora in milk. Our conclusion is that the presence of the rennet-forming organisms may be a factor, but not of major importance, especially in view of the demonstrated importance of the composition of the milk salts.

CAUSES FOR DIFFERENCES IN THE SALT COMPOSITION OF MILK.

There are comparatively few data available in the literature on the factors that influence the salt composition of milk. The factors that are suggested are the stage of lactation and the feed.

The work of Trunz (4) shows that the ratio of calcium to phosphorus is higher toward the end of the lactation period than during the early part. On the basis of these results most trouble would be expected when the cows are approaching the end of the lactation period. The albumin content also is highest at the beginning and at the end of the lactation period, as shown by the work of Hunziker (5) and Eckles and Shaw (6), so that this factor also tends to make the coagulation more pronounced at the time when most cows are either freshening or drying off.

The data in the literature on the effect of the mineral content of the feed upon the salt composition of the milk are conflicting. Schmidt (7), Musso (8), Hess and Schaffer (9), Neumann (10), and Schrodtt and Hansen (11), claim to have obtained a positive effect, while Weiske (12) and Hart, McCollum, and Humphrey (13) report negative results. By feeding calcium phosphate Auzinger (14) influenced the alcohol test of the milk, and van Dam (15) influenced the rennet coagulation of milk in a similar manner. Of the data available, those on the effect of green feed show the most pronounced effect. Hess, Unger, and Supplee (16) have shown that pasture feeding caused a marked increase in the citric acid and phosphorus content. Supplee and Bellis (17) have also shown an increase in the citric-acid content on green feed.

These results give us a logical explanation for the observation that the troublesome heat coagulation is most prevalent during the fall, winter, and early spring, and for the observation that there is a sudden improvement when the cows go on pasture. During the winter months when most of the cows are either freshening or drying off, the calcium content and the albumin content are higher and, the cows being stall fed, the citric acid content is lower than during the rest of the year. It has been demonstrated in this paper that all three of these factors cause an increase in the coagulation. In the spring when the cows go on pasture, there is a marked increase in the citric acid content and, as a result, the coagulation is decreased.

CONCLUSIONS.

1. The main factor in the heat coagulation of evaporated milk is the salt composition of the milk. There is a balance between the calcium and magnesium and the citrate and phosphate. An excess of either of these two classes of salts causes the coagulation; a proper balance produces the most stable condition. In evaporated milk where the coagulation is due to an unbalanced condition of the salts, this condition has been found to be due to an excess of calcium and magnesium in all cases, so that the addition of sodium citrate or di-sodium phosphate was required to improve the milk.

2. Other factors in the coagulation of evaporated milk, given in the order of importance, are: Albumin content, acidity, and rennet-forming organisms.

3. The effect of preheating is attributed partly to the precipitation of the albumin and partly to the precipitation of soluble calcium salts.

4. The explanation is suggested that the troublesome heat coagulation is more prevalent in winter because (1) most cows are freshening or drying off at this time and as a result the albumin content and the calcium content of the milk are higher; (2) due to the lack of green feed, the citric acid content of the milk is lower in winter.

5. There is a sudden improvement when the cows go on pasture due to the increase in the citric acid content of the milk.

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Chairman PAGE. The next paper on the program is "Factors influencing the heat coagulation of milk and the thickening of condensed milk," by Alan Leighton and E. F. Deysher, of the United States Department of Agriculture. Since both authors are absent, this paper will be read by title. "The keeping quality of dry milk" will now be presented by Dr. G. C. Supplee.

THE KEEPING QUALITY OF DRY MILK.

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The manufacture and utilization of dry milk has increased steadily during the past few years, and even though considerably less than 1 per cent of the total of the world's milk production is now dehydrated, the product commands a unique interest for many who are concerned with various phases of the dairy industry. Since the successful merchandising of milk, or milk products which are to be used for food, involves to a greater or less degree the question of perishability, the relative length of time which analogous products will keep in good condition must be taken into consideration in judging their adaptability for certain purposes, and also in determining their ultimate economic importance. The preservation of concentrated semifluid milk and desiccated milk presents but few problems in common. The essential features in the preservation of the former are the application of heat, high concentration of solids and prevention of microbial contamination during and after manufacture; whereas, the preservation of desiccated milk is dependent almost entirely upon the removal of water to a degree which prevents the multiplication of microorganisms. Although dehydration is efficacious in preventing the types of deterioration to which natural fluid and semifluid milks are subject, deteriorations of another character brought about by entirely different agencies are common to all desiccated milks.

There are numerous conceptions of the indefinite periods during which dry milk is claimed to retain its original characteristics, and it is not an easy task to harmonize either the varying opinions or the experimental evidence from different sources. There is more common agreement, however, as to what constitutes deterioration in this product. In referring to the characteristic changes and the factors which enhance or retard them, it is desirable to consider separately the powders made from machine-skimmed milk and those which contain any appreciable amount of fat.

Deterioration in the skimmed-milk product is usually manifested by the development of a stale condition which is readily detected by a characteristic taste and odor, decreased solubility of the casein, and frequently a darkening of the color. It has been observed that

a greater degree of darkening takes place in those powders made from milk to which alkali carbonates or bicarbonates were added before drying. The chemical changes involved in the transition from freshness to staleness have not been clearly traced. It is known, however, that moisture, either that originally contained in the product or that absorbed from the atmosphere, is a particularly active factor in hastening the development of the undesirable characteristics. Other things being equal, the length of time before the appearance of these defects seems to be inversely proportional to the moisture content of the product. Investigation has shown that of the total amount of casein in milk powder capable of forming a normal suspension in water when fresh, 90 per cent retains this same ability after one year when the moisture content was maintained below 3.50 per cent; 60 per cent was capable of suspension after one year when the moisture content was slightly increased from 1.95 per cent to 5.15 per cent; and only 55 per cent was capable of remaining in suspension after seven months when the moisture content was maintained at 5 per cent from the time of manufacture. The slow circulation of air with a relative humidity of 75 to 80 per cent through partially skimmed-milk powder increased its moisture content from 1.95 per cent to over 8 per cent in 25 days, at the end of which time only 52 per cent of the casein could be normally suspended; after 53 days the moisture content had increased to approximately 11 per cent and practically none of the casein retained its original suspensibility. Parallel samples, through which dry air was circulated at the same rate, showed that the casein retained practically its entire original ability for suspension after six months.

From these results and others which have been recorded from time to time, it appears that the moisture content of milk powder is one of the vital factors determining its keeping quality. The prevention of deterioration due to this agency would not be a particularly difficult matter if the product did not possess a marked capacity for absorbing moisture from the atmosphere. The determinations of humidity equilibria of different milk powders show that in an atmosphere with a relative humidity of 20 to 30 per cent the moisture content of skimmed-milk powders is between 3.5 per cent and 4.5 per cent; at humidities between 50 and 60 per cent, it is between 6 and 7 per cent; and at humidities between 70 and 80 per cent the moisture content is between 9 and 12 per cent. From these results and those previously mentioned it is evident that in order to delay the onset of those types of deterioration induced by moisture, absolute protection from the air is necessary.

Dry milk containing fat is not only subject to the same developmental defects as the skimmed-milk powders, but to another type of deterioration as well. It is well known that unstable fats in a finely divided state are prone to undergo certain changes which render them undesirable as foods, and this is particularly true of the fat in milk powder. The rapidity with which such powders deteriorate has undoubtedly been an important reason why dry whole milk has not been manufactured on a larger scale. During recent years the incentive for placing dry-milk manufacture on a sound scientific basis has resulted in a more thorough study of the factors which tend to hasten or retard the development of these defects, and without doubt the

information obtained has been largely responsible for the increasing success with which such powders are now being marketed.

The term "rancidity" is usually used to designate any fatty deterioration in dry milk. Unfortunately the different conceptions of what is meant by rancidity are at variance; and it may not be out of place to venture the opinion that the different interpretations of this term have been a real handicap in the correlation of the results from different investigations. The term "rancidity," as will be used herein, refers to that type of deterioration which is manifested by a distinctive odor suggesting butyric acid or a compound in which there is a natural impulse to assign its aromatic properties to that acid. This description may not coincide with others which have been given, but it will at least serve to differentiate between one particular defect and another—tallowiness—to which reference will be frequently made.

Milk powders containing fat usually become either rancid or tallowy after prolonged storage. The length of time before the appearance of these defects depends upon a number of conditions, some of which are clearly understood while others are not. Before enumerating some of the things which are known to accelerate or retard their development, it is desirable to refer to the two more common methods of manufacture—the spray processes and the rotating double-cylinder process, familiarly known as the Just or Just-Hat-maker method. There is a prevalent belief that whole-milk powder made by the former processes does not keep as satisfactorily as that made by the latter method. Systematic investigation has indicated that this difference is only applicable as a very broad generalization, many exceptions, both as to the duration of time and the character of the defect being found. It has been observed that rancidity occurs more frequently in spray-process powders than in those made by the Just process, tallowiness being the principal defect encountered in the powders made by this method. The frequency of appearance of rancidity in the former powders seems to depend to a certain degree upon the particular spray method used. Tallowiness, when found in these products, as it frequently is after prolonged storage, does not appear to be similarly influenced. The greater prevalence of rancidity in certain spray-process powders suggests a certain variability in significant operating practices. It is possible that the degree of heat applied to the milk either before or during the dehydrating process may have a direct bearing upon these differences by virtue of the effect upon subsequent activities of enzymic material present in the fluid milk. It has been found that lipolytic enzymes are capable of activity in moisture concentrations as low as those normally found in milk powder. Furthermore, it has been found that such enzymes artificially introduced into Just-process powder of low moisture content caused the development of a strong rancid condition within a few weeks, whereas parallel samples containing none of the active material were not similarly affected, but did develop tallowiness after a longer period of time. Attempts made to induce tallowiness in those samples which had previously become rancid were not successful. These results are of significance in the light of the fact that enzymes are not usually destroyed by the spray methods in common use, whereas they are known to be inactive in powders made by the

Just process. This evidence, therefore, indicates that biological agencies may be important factors in the development of rancidity in powders made by the former methods.

It is not to be inferred that tallowiness is of infrequent appearance in these powders. There is considerable evidence to support the belief that the agencies causing this defect are operative in the deterioration of all powders, but, as has been pointed out, when the rancid condition attains ascendancy, typical tallowiness is less liable to be manifested. Observations made upon several thousand samples of Just-process powder, in which the conditions of manufacture and storage were carefully controlled, have shown that tallowiness is by far the most significant type of fat deterioration in these products. In studying the conditions affecting its development, it has been observed that its typical manifestation is more frequently noted in powders of low moisture content. In powders containing excessive moisture, the tallowy condition may be masked to a degree which renders it nearly unrecognizable. However, upon making chemical studies of the extracted fat, it is found that the same characteristics prevailed in the fat from both the high and low moisture products. Among the changes in the fat constants shown by such studies, a decrease in the iodine number is almost universally found. Direct evidence is therefore available pointing toward oxidation as a constantly operating factor in the deterioration of milk powder. Even though oxidative changes may also take place in those powders which develop a rancid condition, it is believed that this type of change is the predominating, if not, the sole cause of tallowiness.

While data which have been obtained do not entirely exclude other agencies as possible contributing factors in the development of tallowiness, it has been definitely shown that conditions which accelerate oxidation also hasten the development of this defect, and vice versa. A temperature of 32° F. has been found to prevent manifestation of tallowiness in partially skimmed-milk powder for over 18 months. Parallel samples held at 52° F. show evidence of tallowiness after 12 to 13 months, whereas, in samples held at 70° to 75° F., the defect was manifested after 5 to 6 months. The intensity of the tallowy condition rapidly increases at the higher temperature. It has also been found that its rate of development, even after its first appearance, may be promptly arrested by removal to a low temperature.

Metallic catalyzers, particularly metallic copper or the salts of copper, have been found to be especially active in hastening the development of tallowiness. Copper in the form of organic salts when introduced into the dry powder or into the milk before drying caused its earlier manifestation. When such salts were incorporated in the liquid milk at the rate of 10 to 15 parts of copper per million parts of milk solids, tallowiness invariably developed within 50 days at room temperature. When the metal was introduced at the rate of 100 to 200 parts per million it was strongly manifested in a much shorter time. Milk held or heated in contact with metallic copper has been found to take up the metal in amounts varying from less than 1 part per million to as high as 7.4 parts per million. Powder made from whole milk which had taken up variable amounts

of copper between these extremes reflected the presence of the metal in its keeping qualities. Powder made from milk containing copper at the rate of 0.7 to 1 part per million, showed evidence of strong tallowiness directly attributable to the metal after 9 to 10 months storage at room temperature, whereas, powder made from the same milk, but not exposed to the metal did not become tallowy until after 12 months under the same storage conditions. Whole-milk powder made from similarly treated milk, but with a copper content of 3 to 7 parts per million, showed distinct evidence of tallowiness after 5 to 7 months storage, whereas the untreated milk containing no copper remained in good condition for over 12 months. From these results it would appear that contamination by copper or copper salts, such as might result from factory equipment, is a menace to the keeping quality of milk powder containing fat. The evidence is also in harmony with what is known regarding the oxidation accelerating properties of this metal.

The effect of iron salts and metallic iron studied in the same manner as metallic copper and its salts proved to be less pronounced than those of the latter. In cases where the higher concentrations of iron salts were introduced in the liquid milk before drying, tallowiness directly attributable to these compounds was very evident after 100 to 120 days, whereas in the product containing the lower concentrations 5 to 7 months elapsed before its appearance. Experiments with metallic iron showed that this metal was taken up by milk in much larger quantities than copper, its effect however, in hastening oxidation and tallowiness was much less pronounced than that with smaller amounts of copper similarly introduced.

The storing of milk powder in the absence of oxygen and in oxygen concentrations different than that in which it is found in the air furnished further evidence that oxidation is the predominating cause of tallowiness. The holding of powder in vacuum, nitrogen, and carbon dioxide gas has been found to delay the appearance of the defect for long periods. The results, however, have not been conclusive in proving that such methods can be relied upon to preserve the product indefinitely. Experimentation with these methods has indicated mechanical and physical problems which may prove difficult to solve. It appears that if milk powder containing fat is to be kept in good condition for a period of years, complete absence of oxygen is essential. Whether vacuum packing processes or the displacement of air by an inert gas will accomplish the removal of all oxygen from a product possessing the physical characteristics of dry milk, is still a matter to be determined. The effects of variable oxygen concentrations in the gas enveloping milk powder is indicated by the following data: Partially skimmed milk powder packed in pure oxygen gas became strongly tallowy after 60 days storage at room temperature. The same product packed in air did not become tallowy until after 5 to 6 months. When it was packed in a gas mixture containing 10 per cent oxygen, the defect became evident after the same length of time as the air-packed samples; when packed in a gas mixture containing 5 per cent oxygen it usually appeared after 8 to 9 months; and when packed in a gas containing $2\frac{1}{2}$ per cent oxygen the manifestation of the defect was further delayed, but usually appeared after 11 to 14 months.

The amount of fat present in the powder appears to have an important bearing upon the length of time before tallowiness becomes evident. Granting the accuracy of the conclusion that any factor which enhances oxidation will accelerate the development of this defect, it is logical to assume that the greater the exposed area of a unit amount of fat the sooner will the results of oxidation become noticeable. Carefully controlled investigations with powders made by the Just process have shown that, other things being equal, the higher the fat content the longer the time before tallowiness is manifested, and vice versa. Experimental powders made with a varying fat content, as well as those made on a commercial scale, show substantial agreement in respect to their relative keeping quality when held under comparable storage conditions. Powder containing between 5 and 6 per cent fat was almost always tallowy after 3 to 4 months storage at room temperature; that containing 12 to 13 per cent fat rarely showed this condition under 5 to 6 months, and more frequently not until after 7 to 8 months. The powder made from whole milk and containing from 26 to 27 per cent fat usually kept satisfactorily for 10 to 13 months; and that made from a thin cream containing 50 to 55 per cent fat usually remained in good condition after 15 to 18 months. The fat constants determined periodically confirmed the quality observations by showing more rapid oxidation in those powders containing the lower amount of fat.

As was stated earlier in this paper, the conceptions of the length of time which milk powder will keep in good condition vary widely. In view of the factors which have been found to have an effect upon its keeping properties, both the adverse and favorable conceptions appear to be justified. Even though dry milk is a stable product compared with natural fluid milk or concentrated milks, in so far as susceptibility to microbial deterioration is concerned, it will not retain its original characteristics indefinitely. There is every reason to believe, however, that considerable progress is being made in furthering the search for important information and in developmental projects, which, when utilized to the fullest degree will eliminate at least some of the troublesome problems now encountered in the preservation of this product.

Chairman PAGE. The next number is "The keeping quality of butterfat with special reference to milk powder," by Dr. Holm and Mr. Greenbank. Doctor Holm will present this paper. [Applause.]

THE KEEPING QUALITY OF BUTTERFAT, WITH SPECIAL REFERENCE TO MILK POWDER.

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Butterfat held in storage sometimes undergoes objectionable changes, producing characteristic odors and flavors classed as rancid, tallowy, and fishy. Much confusion has arisen concerning the use of the two former terms. It is generally agreed, however, that the term "rancid" should be applied to hydrolytic changes only, while the term "tallowy" should be used where other changes are the cause of the off odor and flavor, excluding fishiness. Inasmuch as this paper will deal essentially with the problem of milk powders, it becomes

unnecessary to include here those changes which are rarely encountered if milk is handled and treated by the best known methods before it is converted into the powdered form. Though the presence of lipases in milk has never been definitely proved, it is undoubtedly a question of minor importance in the powdered-milk industry, for in most cases the milk receives heat treatment before it is manufactured into milk powder that would destroy all enzyme action. Whether the hydrolysis caused in a whole-milk powder that has been manufactured from milk which received little or no heat treatment is caused by a lipase or by the catalytic effect of some constituent of the powder, is beside the issue and of minor importance practically, though it has some theoretical interest.

The condition that sometimes develops in butter, known as fishiness, may also develop in milk powder if the moisture content is too great. The critical point in regard to the percentage of moisture that may be present without causing fishiness is above that usually found in any milk powder properly manufactured and, therefore, becomes of importance only when the powder is improperly handled or stored. This point will be discussed later.

The real problem in the storage of milk powder is the tendency of the powder to become tallowy.

The production of tallowiness is entirely a question of changes in the fat which may be attributed to an autoxidation process, as we have shown.¹ The question of the promotion of this process, or catalysis, is significant, and among the many agents and factors involved, that have been mentioned, are heat, light, moisture, acidity, and enzyme action. In view of the fact that the heat treatment given milk before it is manufactured into powder destroys any enzyme action, the question of enzyme will not be discussed. With regard to the other factors mentioned there is much doubt as to the exact nature of their action.

EXPERIMENTAL PART.

In order to obtain an idea of the keeping quality of various milk powders and the changes that occur under various conditions, several preliminary experiments were carried out.

It had already been noted that various powders obtained from manufacturers varied greatly in the percentage of moisture they contained; and in view of the fact that moisture has been mentioned by numerous investigators as one of the factors favoring the production of tallowiness, the relation of moisture to the changes in different powders was studied, with regard to both the avidity of a powder for moisture and the relation of moisture to keeping quality. Samples of two spray powders and two drum-dried powders were placed over sulphuric acid of varying concentrations. Over high sulphuric acid concentrations, where the vapor pressures were low, these powders would lose moisture; and over the lower concentrations moisture would be taken up. After several days the exchange of moisture between the acid and the powder samples would come to equilibrium (as shown by the constant weight of the samples). The samples

¹ G. E. Holm and G. R. Greenbank. *J. Exp. Biol. and Med.*, v. 20, pp. 176-77 (1922); *J. Ind. Eng. Chem.*, v. 15, pp. 1051-1053 (1923).

were then transferred to Mason jars and kept in a laboratory cupboard at approximately 25° C., and from time to time the odor was noted and samples were taken for testing. Under the conditions of storage, deterioration was rapid and even a skim-milk powder would rapidly become tallowy. The results obtained with various powders are recorded in Tables 1 and 2.

TABLE 1.—*Influence of moisture content upon production of tallowiness in whole-milk powder.*

DRUM DRIED.

Moisture.	Odor after 24 days.	Kreis test after 24 days.	Odor after 50 days.	Kreis test after 50 days.	Odor after 73 days.
<i>Per cent.</i>					
0.16	Faintly tallowy.....	+++	Tallowy.....	++++	Tallowy.
.34	do.....	++++	do.....	++++	Do.
1.32	.....	++	do.....	++	Do.
1.88	.....	+	do.....	+	Do.
2.60	.....	+	Slightly fishy.....	++	Slightly fishy.
5.22	.....	+	Fishy.....	++	Fishy.
6.72	.....	+	do.....	++	Do.

SPRAY DRIED.

Moisture.	Odor after 9 days.	Odor after 14 days.	Kreis test after 19 days.	Odor after 37 days.	Kreis test after 37 days.	Odor after 50 days.
<i>Per cent.</i>						
1.54	Tallowy.....	Tallowy.....	+	Tallowy.....	+++	Tallowy.
1.82	do.....	do.....	+	do.....	+	Do.
2.28	do.....	do.....	+	do.....	++	Do.
3.00	do.....	do.....	+	Slightly off.....	+	Do.
3.78	do.....	do.....		do.....	++	Do.
7.92	do.....	do.....		Slightly fishy.....	++	Fishy.
8.59	do.....	do.....		do.....	++	Do.

TABLE 2.—*Influence of moisture on production of tallowiness in skim-milk powder.*

DRUM DRIED.

Moisture.	Odor after 35 days.	Kreis test after 35 days.	Odor after 45 days.	Odor after 48 days.
<i>Per cent.</i>				
0.38	Tallowy.....	++	Tallowy.....	Tallowy.
.70	Faintly tallowy.....	++	do.....	Do.
1.75	do.....		do.....	Do.
2.38	.....		.....	.....
2.99	.....		.....	.....
7.62	.....		.....	Faintly fishy.
8.04	Off odor.....		Faintly fishy.....	Fishy.

SPRAY DRIED.

Moisture.	Odor after 25 days.	Kreis test after 25 days.	Odor after 35 days.	Odor after 45 days.
<i>Per cent.</i>				
1.20	Faintly tallowy.....	Tallowy.
1.66	do.....	Do.
2.60	Do.
3.16	Off odor.
3.85	Slightly fishy.
9.56	Fishy.
10.67	Do.

The first noticeable result of these experiments was that the drum-dried powder was more easily dehydrated than the spray powders. This is due to the destruction of the colloidal properties of the proteins by the high heat treatment the drum powder receives in the drying process. The second and exceedingly striking result was that tallowiness appeared first in the samples of lowest moisture content. This result was contrary to general belief and to statements made by various workers, that moisture aids the production of tallowiness. The experiments were therefore repeated, with identical results. Each time it was shown that a drum powder of approximately 2 per cent and a spray powder of 3 per cent moisture content were optimum for preventing tallowy odors and flavors.

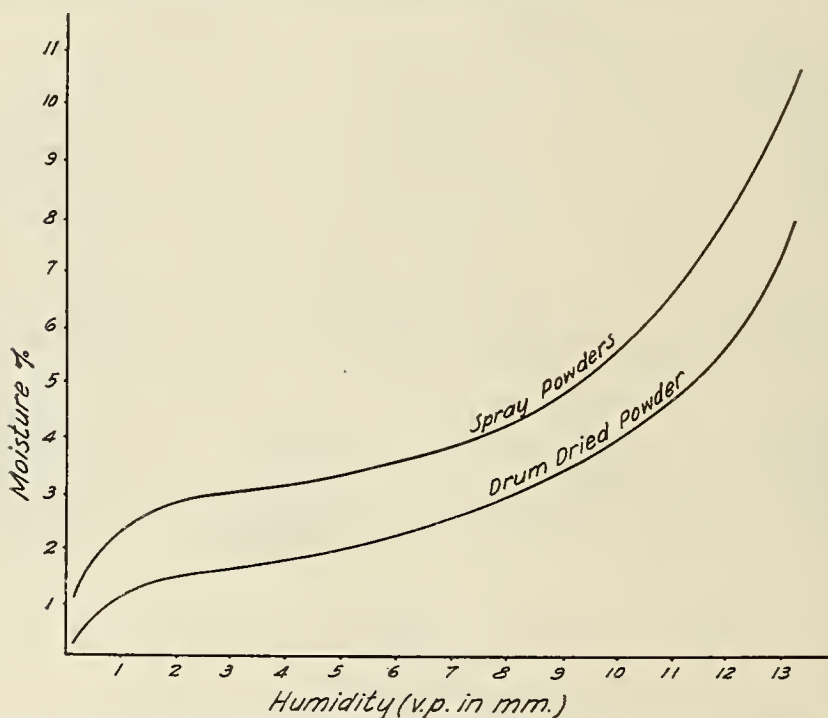


FIG. 1.—Moisture-vapor pressure equilibrium curves for spray and drum-dried powders.

Above 4 per cent moisture content a fishy flavor and odor always developed.

The tests made with the Kreis reagent were not strictly quantitative, but they verified in all cases the test of the olfactory sense. In order to bring out the facts more clearly, the hydration curves of the powders were plotted.

Figure 1 indicates the avidity that a spray powder has for moisture and the ease with which a powder that has received a high heat treatment in drying will lose moisture. Over concentrated sulphuric acid (H_2SO_4) all the spray powders used retained about 1 per cent of moisture, while the drum-dried powder lost approximately all of its moisture. In other words, for equal moisture contents the vapor pressure of a drum powder is higher than the vapor pressure of the spray powders. It has been noted in Table 1 that optimum conditions for the prevention of tallow-

iness exist at a lower moisture content (1.88 per cent) for the drum powder than it does for the spray powders (approximately 3 per cent). Also it was noted that fishiness occurred in the drum powder at a lower moisture content than it does in the spray powders. If the figures for the various moisture contents at which these changes occurred in the various powders are now referred to Figure 1, it is significant to note that at these moisture contents the different powders have approximately the same vapor pressures. In Figure 1 it will also be found that the optimum moisture contents are beyond that part of the hydration curve which may be considered as representing firmly bound water or truly adsorbed water, and at the points where we have the optimum keeping conditions we have some loosely bound or free water. This again raises the question of the rôle played by water in the production of tallowiness, and the question as to whether or not free water tends to retard the reaction, as seems to be the case in these experiments.

Due to the short periods of time that it was necessary to hold the samples in storage under the above conditions, before they became tallowy, it is apparent that the moisture content is not altogether a controlling factor. It was, therefore, decided to determine to what extent the keeping quality of milk powder is dependent upon other factors, especially the oxygen supply. To ascertain the efficiency of carbon dioxide (CO_2) in retarding the chemical changes, two sets of samples of a whole-milk powder were placed in atmospheres of carbon dioxide and oxygen.

TABLE 3.—*Effect of atmospheres of oxygen and carbon dioxide upon the production of tallowiness.*

OXYGEN.

Method of preparation.	Moisture.	First off odor	First Kreis test.	Kind of powder.
	<i>Per cent.</i>	<i>Days.</i>	<i>Days.</i>	
Drum.....	2.40	19	+ 19	Whole milk.
Spray.....	2.39	17	+ 17	Do.
Drum.....	2.50	19	+ + 19	Skim milk.
Spray.....	3.00	-----	1+ 19	Do.

CARBON DIOXIDE.

	<i>Per cent.</i>	<i>Days.</i>		
Drum.....	2.40	26	² + 26	Whole milk.
Spray.....	2.39	26	+ 26	Do.
Drum.....	2.50	26	+ 26	Skim milk.
Spray.....	3.00	26	+ 26	Do.

¹ Weak.

² Faint.

Table 3 indicates that in these powders there was practically no difference in the length of time that was necessary to produce tallowiness in each sample. In an atmosphere of oxygen, however, the first trace of tallowiness was noticeable in approximately 19 days, while in a carbon dioxide atmosphere a faint off odor was noticeable in 26 days.

The displacement of the air in the powder (not occluded air) retarded oxidation, but did not completely prevent this chemical change. Even in a drum powder, where little air is occluded, the change seemed to be almost as rapid as in the spray powders. The conclusion was drawn that dissolved oxygen is of as great importance in the production of tallowiness in milk powders as is free oxygen. The solubility of oxygen in butterfat was therefore determined, and it was found that in a saturated oxygen atmosphere the solubility was roughly 8 per cent by volume. The volume dissolved at the partial pressure of oxygen in air will, however, be considerably less.

These experiments were of a preliminary nature, but indicated clearly that in order to understand the oxidation of butterfat and the changes that take place when tallowiness occurs in milk powder, and in order to understand the factors concerned, a thorough study of pure butterfat itself was indispensable. It had been shown that only through work upon the fat could the measurements be carried out with precision and the factor regulated and studied with care.

EXPERIMENTS WITH PURE BUTTERFAT.

Our previous experiments had indicated that in order to obtain a thorough knowledge of how and when tallowiness occurs it is necessary to know the course of autoxidation and the characteristic changes that occur; also, to have an accurate measure of tallowiness and the extent of oxidation, and to know how they are interrelated. Pure dry butterfat was prepared from freshly churned sweet cream. A sample of this fat was placed in a flask containing a gas-tight stirrer inserted into the stopper. The inlet tube of the flask was connected to a gas burette filled with oxygen and the stirrer was run at a high speed. The flask was held in a water bath maintained at 95° C. Samples were withdrawn from time to time and tested. It was noted that fresh butterfat required an induction period of from two to three hours before oxidation began. After once begun the rate was rapid, especially at this temperature, and was of a logarithmic nature. The properties of the fat during the two periods are tabulated in Table 4.

TABLE 4.—*Properties of autoxidized butterfat in the various phases of oxygen absorption.*

No.	Period of induction.	Period of logarithmic absorption.
1	No oxygen absorption.....	Oxygen absorbed rapidly.
2	Very slight or no change in color of butterfat.....	Bleaching (loss of color of butterfat).
3	Negative or faint Kreis test.....	Positive Kreis test.
4	Sweet odor.....	Tallowy odor.

It was noted also that loss of color of the butterfat, tallowiness, and a positive Kreis test appeared almost simultaneously with the first absorption of oxygen.

The rate of the oxidation and the changes in butterfat are better illustrated by Figure 2.

It was soon apparent that there was little difference in the tallowiness of a slightly oxidized and a highly oxidized butterfat when judged by the olfactory sense, but there was a great difference in the intensity of the Kreis test upon these fats.

Though the statement has been made by various workers that the Kreis test is not proportional to the rancidity (tallowiness), it was decided to determine to what extent it could be used to measure the progress of the oxidation and what relation it has to the degree of tallowiness. The iodine number has been used in some instances to measure oxidation changes, and therefore this method as well as the iodine-liberation tests were tried upon the same samples of fat that were used in the Kreis tests.

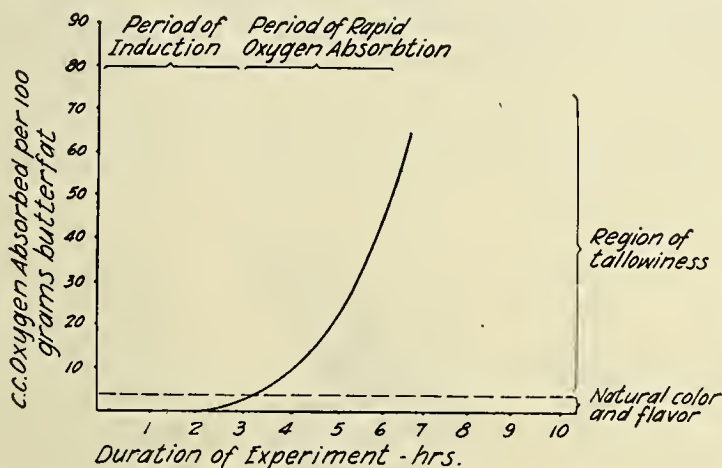


FIG. 2.—The nature of oxygen absorption at 95° C. and the changes that occur in the different stages of the absorption.

A sample of 400 grams of pure dry butterfat was autoxidized as previously described. At intervals of known oxygen absorption samples were taken and the various tests made.

TABLE 5.—Properties of butterfat (400 grams) that has absorbed various amounts of oxygen.

Oxygen absorbed.	Acidity N/14 HCl per 5 grams.	I ₂ No.	I ₂ liberated from KI in 24 hours by 1 gram of fat.	Kreis test. Amount necessary for equiva- lent color intensity.	K. Amount of fat × volume of oxygen.	K. Basis of 100 grams fat.
Cubic centimeter.	Cubic centimeter.		Grams.	Grams.		
0	0.52	31.50	.....	Neg.	.....	.....
5	.88	31.44	.....	0.20	.....	.....
300	.90	30.42	0.0006	.014	4.20	1.05
500	1.05	30.80	.0010	.0090	4.50	1.25
800	1.65	29.18	.0017	.0055	4.40	1.10
1,100	2.00	28.70	.0026	.00385	4.23	1.06

Table 5 shows clearly that neither the iodine absorption test nor the iodine liberated from potassium iodide by these samples can be used to detect small differences in oxidation. The Kreis test, however, furnishes an exceedingly fine measure of the degree of oxidation, in that it shows positive results even before the oxygen ab-

sorption reaches the logarithmic phase, and further, *its intensity is a quantitative measure of the amount of oxygen absorbed by a butterfat, as shown by the table given.* The intensities of the Kreis tests in Table 5 were determined by ascertaining the amounts of each sample that would give equivalent color intensities with the phloroglucin hydrochloric acid reagent. In view of the sensitiveness of the Kreis test, and in view of its quantitative aspects, it has been used throughout our work to measure the progress of oxidation in butterfat samples.

In the preliminary work upon the various milk powders, it seemed that the water had a retarding effect upon the production of tallowness. With an accurate measure at hand it was now possible to measure the progress of the oxidation very accurately. The effect of the presence of water upon the length of the induction period was first studied at 95° C., as already specified, with the results shown in Figure 3.

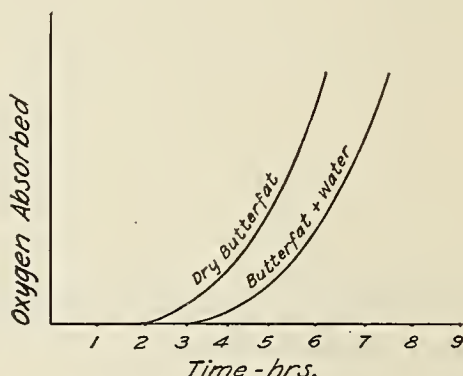


FIG. 3.—The relative effect of water upon the rate of autoxidation of butterfat at 95° C.

The effect of the water seemed to be to increase the length of the induction period and to retard oxidation. Pure butterfat was then tried in the same manner as milk powders had been tried in our preliminary experiments. Samples were placed in Petri dishes over sulphuric acid of various concentrations, and allowed to stand at room temperature until one of the samples was thoroughly bleached. All the samples were then tested quantitatively with the Kreis test, and various characteristics were noted. The results are tabulated in Table 6.

TABLE 6.—*Properties of samples of butterfat stored at various vapor pressures in the absence of light.*

Sam- ple No.	Vapor pressure.	Acidity, N/20 NaOH per 5 grams.	Color.	Odor.	Kreis test (propor- tionate intensi- ties).
	Milli- meters.	Cubic centi- meters.			
1	0.20	0.45	Bleached.....	Tallowy.....	5
2	4-5	.40	Slightly bleached.....	Slightly tallowy.....	4
3	9	.30	Very slightly bleached.....	Not sweet.....	2
4	(1)	.30	Natural.....	Sweet.....	1

¹ Saturated.

The effect of the presence of water was again tried by adding a small amount of water to one sample, thoroughly shaking, and then allowing the sample to solidify. This sample and a check were then placed in dishes open to the air, without access to light. The sample containing the water always showed retarded oxidation.

Another experiment was carried out in which the humidity was controlled by using various concentrations of glycerin. These experiments did not show the effect of humidity so clearly as did those with sulphuric acid. One important observation of great value was noted which had also been noted in our former experiments, namely, that though the Kreis test of samples indicated equal progress of oxidation, tallowiness was seldom noticeable in the sample stored in a high humidity until the sample was almost fully bleached, while in a low humidity tallowiness was always pronounced before the sample was even slightly bleached. These results are in excellent accord with the observations upon milk powders, and tend to explain why tallowiness appears first in powders of low moisture content. This point will be discussed later.

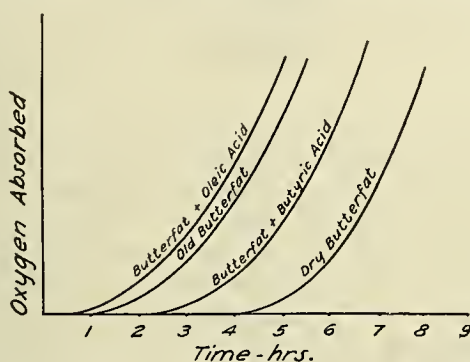


FIG. 4.—The relative effects of acids upon the autoxidation of butterfat at 95° C.

Throughout the work it had been noted that supposedly fresh samples varied greatly in the susceptibility to oxidation. This could only be explained by assuming that the susceptibility was dependent upon some inherent characteristic of the fat. In view of the fact that there was a slight variation in the acidity of the samples, the effect of the acidity and of various acids upon the susceptibility to oxidation was studied. Old butterfat which had been kept in storage for three years, but which showed a negative Kreis test, was also studied.

Samples of these butterfats were subjected to oxidation at 95° C. under conditions as described. Figure 4 shows the effect of butyric and oleic acids upon the length of the induction period. The autoxidation curve for old butterfat is also given.

Figure 4 shows that the presence of acids accelerates oxidation and the production of tallowiness, and that oleic acid is more strongly catalytic than the saturated fatty acids. The sample of old butterfat, though it was of the same acidity as the fresh sample, oxidized almost immediately. The explanation of this must lie in the type of acid found in the old butterfat. It is probable that aging has caused hydrolysis, and displacement of the weaker acids

(oleic, etc.) by the stronger acids of lower molecular weight. It is probable also that there has been a very slight autoxidation in the old butterfat, and the compounds formed in this process are strong catalysts, as shown by the fact that when autoxidation has begun it proceeds rapidly. (See Fig. 4.) This can also be shown by adding a small amount of an oxidized fat to a fresh sample. The autoxidation of this sample is then rapid.

The relative value of various fatty acids as catalysts for the oxidation of butterfat was tried by adding small amounts of various acids to samples of the same fresh, dry butterfat and allowing these sample to stand open to air in the absence of light until bleaching occurred. The Kreis test was then applied to the samples.

TABLE 7.—Catalytic effects of acids in oxidation.

Sample.	Color.	Kreis test.
Check.....	Natural.....	0
Check+butyric acid.....	Very slightly bleached.....	1
Check+valeric acid.....	do.....	1
Check+caproic acid.....	Bleached.....	1.2
Check+oleic acid.....	Completely bleached.....	12
Do.....	do.....	60

Table 7 indicates that acids are catalysts for the reaction, and also that the fatty acids of higher molecular weight are better catalysts than those of lower molecular weight. The experiments indicate that perhaps the acidity of the fat plays a leading rôle in its susceptibility to oxidation. To determine to what extent this was the case, it was decided to try to prepare fats of good keeping quality with respect to oxidation. Steam distillation and thorough washing of the butterfat suggested themselves as the two most plausible methods to prepare these fats if acids play a prominent rôle in the oxidation process.

A sample of butterfat was prepared from freshly churned butter, and 400 grams of this fat was steam distilled. At 15-minute intervals samples were taken, tested, and placed in open vessels in the absence of light. At intervals of two weeks, these samples were tested to determine the rate of oxidation. (See Table 8.)

TABLE 8.—Keeping quality of butterfat with reduced acidity, as shown by tests made immediately and after 2, 4, and 8 weeks.

Time of distillation.	Acidity, cubic centimeters N/20 NaOH per 10 cubic centimeters of fat.				Color.				Odor.				Taste.				Kreis test.			
	0	2	4	8	0	2	4	8	0	2	4	8	0	2	4	8	0	2		8
Check.....	0.3	0.3	0.3	0.3				SB				Tal.				Off				++
15 minutes.....	.2	.2	.2	.2				SB				Tal.				Off				+
30 minutes.....	.15	.15	.15	.15																+
45 minutes.....	.15	.15	.18	.18																
60 minutes.....	.25	.25	.25	.30			SB	B				Tal.			Off	Off	+	++	+++	

Tal.=Tallowy.

SB=Slightly bleached.

B=Bleached.

Steam distillation improved the keeping quality of the butterfat. The samples of lowest acidity seemed to keep the best. Continued distillation, however, lowered the keeping quality, probably due to hydrolysis and liberation of oleic acid, which is shown in Table 7 to have marked catalytic properties in oxidation.

Another freshly prepared butterfat was thoroughly washed. The acidity was reduced from 0.30 cubic centimeter to 0.10 cubic centimeter N/20 sodium hydroxide per 10 cubic centimeters of fat. This fat, though it was not so thoroughly tested as was the steam distilled, showed marked improvement over the check, but was not of as good quality as was the steam-distilled sample in resisting oxidation.

The feasibility of the use of vacuum to prevent milk powder from becoming tallowy has been suggested. Some preliminary experiments, however, indicated that even in high vacuum tallowiness would occur upon prolonged storage. The reaction is hastened in sunlight, so the effect of sunlight upon various samples of butterfat was studied. A thoroughly washed sample, a steam-distilled sample, and a check were sealed in vacuums and placed in strong sunlight. The check was thoroughly bleached in approximately 7 to 10 days, while the washed and steam-distilled samples showed no change in 2 months. (See Table 9.)

TABLE 9.—*Effect of sunlight upon steam treated and washed butterfat.*

Sam- ple No.	Description.	Time of storage.	Color.	Kreis test.
1.....	Treated (moist).....	2 months.....	Bleached.....	++
2.....	Untreated (moist).....	do.....	do.....	+++
3.....	Treated (dry).....	do.....	Natural.....	—
4.....	Untreated (dry).....	6 weeks.....	Bleached.....	++
5.....	Washed (dry).....	2 months.....	Natural.....	—

SUMMARY.

The course of reaction that occurs when butterfat is autoxidized, and the changes that take place, have been shown. The results indicate that the absorption of very small quantities of oxygen will produce tallowiness and that when autoxidation has once begun it proceeds rapidly. The problem of prevention becomes, therefore, a problem of keeping the reaction within the period of induction.

A study of the influence of various factors upon the oxidation of pure butterfat has shown that the presence of water under certain conditions will retard the oxidation. The interesting fact was noted that the presence of water retarded or prevented the formation of those compounds that produce tallowiness, and though oxidation of two fats may proceed at the same rate the dry butterfat will always show tallowiness before the moist samples. These facts throw some light upon the results obtained with milk powders. An increase in the moisture content of a powder not only retards oxidation but it prevents the formation of those intermediate products (aldehydes, etc.) that give rise to a tallowy odor.

Palmer and Dahle² have attempted to explain the variations in the keeping quality of spray and drum powders upon the basis that a spray powder contains much occluded air, while a drum powder contains little or no occluded air. Results that we have obtained with various powders, where the air in each case was displaced with carbon dioxide, failed to indicate that there was any great difference between two powders with regard to their susceptibility to oxidation, if the vapor pressures of the powders are the same. While it is true that in general a drum powder (not vacuum drum) will resist oxidation longer than will a spray powder, it is doubtful whether this property can be attributed mainly to the occluded air in the powder. There are other factors which are of greater importance in the susceptibility of a powder to oxidation. The question whether or not butterfat will absorb oxygen rapidly is dependent not so much upon the availability of oxygen in quantity as upon the susceptibility of the fat to oxidation.

Furthermore, since tallowiness is produced with exceedingly small amounts of oxygen per volume of butterfat, the amount of oxygen present (occluded, free, and dissolved) must be reduced to exceedingly low proportions in order to exclude the production of tallowiness by this method. But results show that even storage in vacuum will not prevent tallowiness indefinitely. The results given tend on the whole, however, to show that vacuum storage of butterfat, or of dairy products containing butterfat, which contain very small amounts of fatty acid, should make possible the keeping of such products without danger of the development of tallowiness.

Tallowiness is produced by oxidation of the oleic acid radical with subsequent splitting and the formation of aldehydes and acids which possess the tallowy odor. If we assume that the production of tallowiness in butterfat containing fatty acids, stored in vacuum and exposed to sunlight, is due to oxygen absorption, we must also assume a source of this oxygen. While we know that under the influence of ultra-violet light, fatty acids are decomposed, giving carbon dioxide (CO_2), carbon monoxide (CO), and perhaps some oxygen (O_2), we have no proof that this is part of the reaction with which we are here concerned. Since tallowiness is produced in the absence of light in vacuum, upon prolonged storage, it seems probable that some type of rearrangement may be involved in which fatty acids play a part.

The results obtained upon pure butterfat show that perhaps acidity plays a greater part in oxidation than any other one factor. The quality of the milk from which the powder is manufactured would, therefore, determine to some extent the quality of the powder. Of the various processes of manufacture, some are more efficient than others in the amount of acids they may remove, and therefore any powder made by a process where acids are removed to a greater extent will resist oxidation to a greater degree. This is no doubt the real underlying reason for the greater resistance of drum powder to oxidation.

Not only the heat treatment that a milk receives in drying, but also the quality of the milk, may have much to do with the keeping

² Palmer, L. S., and Dahle, C. D. *Jour. Dairy Sci.*, 5 (1922), 240-245.

quality of the product, and this in addition to moisture content undoubtedly explains the cause for variation in samples of a product manufactured at approximately the same time.

Chairman PAGE. The next number on the program "The attainment of bacterial purity in the manufacture of dried milk," by H. Jephcott, R. F. Hunwicke, and N. Ratcliffe, will be read by Mr. Jephcott.

THE ATTAINMENT OF BACTERIAL PURITY IN THE MANUFACTURE OF DRIED MILK.

HARRY JEPHCOTT, M. Sc., F. I. C.; R. F. HUNWICKE, Glaxo Laboratories, London; and NORMAN RATCLIFFE, F. I. C., Glaxo Laboratories, Hamilton, New Zealand.

I. INTRODUCTION.

One of the great advantages of the use of dried milk, particularly in infant feeding, is the elimination of the bacterial contamination which is so commonly met in ordinary fluid milk. Even certified milk will not bear comparison, as regards this feature, with dried milk manufactured under proper conditions of scientific control.

It can not, however, be sufficiently emphasized that the ideal of sterility can not be approached without the exercise of the most meticulous care in every stage of the manufacture. Supplee and Ashbaugh have already drawn attention to this in an interesting paper (*Journal of Dairy Science*, V, No. 2, March, 1922, p. 216).

In the present paper it is proposed to give a brief account of this problem as it has occurred in factories manufacturing standardized dried milk in New Zealand.

At all factories the roller process of drying milk is alone employed, and the bacteriological control of milk powder manufacture can consequently be considered as falling into two distinct sections—the predrying and the postdrying periods.

The former mainly concerns the control of raw milk supplies received at the factories and the care of the milk before drying takes place. Although this is, in our opinion, a matter of great importance, and we contend, we believe with good reason, that the quality of milk powder, especially as judged by flavor, is affected by the cleanliness of the milk supplies, yet since such control is not peculiar to the production of dried milk but is common to any milk factory, we do not propose here to deal with the bacterial control of raw milk, but to confine our attention to the postdrying period.

Delépine has shown that at the knife in roller drying, the powder contained from 10 to 20 bacteria per cubic centimeter of reconstituted milk (1 in 8). Supplee and Ashbaugh showed from 30 to 160 under similar conditions. Our own observations, made when bacterial control of the factories was first instituted, agree with the figures of these investigators, and the problem is mainly one of controlling the subsequent handling of the powder rather than improving the sterility of the powder at the cylinders, although the latter

has been done and our present average at the cylinders is not more than 6 per cubic centimeter.

II. GENERAL RESULTS OF BACTERIAL CONTROL AT FACTORIES.

Bacterial control has now been in operation for some years, but the improvement obtained as a result of its introduction is nevertheless of interest. At the onset, analysis of the examinations of the powder at that period showed an average maximum of 4,500 per cubic centimeter for all factories, and a minimum of 180 per cubic centimeter.

This was not considered satisfactory, and local tests revealed potential sources of contamination. Various modifications and structural improvements designed to overcome these possible defects were made, and improvement at once resulted. The average maximum count for the first three months after the alterations was 1,200 per cubic centimeter and the average minimum 16 per cubic centimeter. Thus there was a reduction of the average maximum by 73 per cent and of the average minimum by no less than 91 per cent.

Meanwhile, the full scheme of bacterial control had become operative and active educational work was carried out among the employees at the various factories. At each factory simple bacteriological demonstrations were given to all members of the staff: what bacterial purity meant, how contamination might arise, and how it could be avoided, were carefully explained.

At the same time, a system of awarding marks to each factory for the bacterial purity of its product was commenced, and these marks were made known to every worker, together with a comparison of the marks awarded to the other factories. The whole staff rapidly took great interest in improving the purity of their product, and a keen rivalry grew up between the various factories.

How far the laboratory control, combined with intelligent cooperation of factory staffs, has improved the bacterial purity of the milk powder is best exemplified by the figures for the first three months of the last season, shown in Table 1.

TABLE 1.—*Bacteria content of samples of milk powder during three months of 1922.*

<i>September:</i>	
Maximum-----	565
Minimum-----	0
<i>October:</i>	
Maximum-----	275
Minimum-----	0
<i>November:</i>	
Maximum-----	198
Minimum-----	0
Average-----	25

Over 90 per cent of the samples during November showed a count of less than 50 per cubic centimeter on agar, while 6 per cent were completely sterile.

III. THE CONTAMINATION OF POWDER DURING REPACKING.

The figures given hitherto have applied to powder in bulk, before being shipped to England. After arrival in England, the powder

is resifted and packed in small containers for the retail trade. There is thus a further process to be gone through, and opportunities occur for possible further contamination of the finished product. In order that the control instituted in New Zealand might be extended to include the final process of repacking in England, regular bacteriological examinations, both of shipments in bulk as they arrive and of the powder after final packing, were instituted.

The improvement shown in the New Zealand figures is naturally reflected by the English figures, though the matter is complicated by the fact that bacteria in milk powder tend to diminish in numbers with the course of time.

That the improvement in the bacterial purity of the finished product was very marked during the first twelve months of bacteriological control, will be seen from the agar count per cubic centimeter.

TABLE 2.—Average bacteria count per cubic centimeter for one month, of milk powder after packing.

	Highest.	Lowest.	Average.
In first month of control.....	3,392	8	338
Twelve months later.....	742	8	88

It will be noticed that the lowest count was the same in both cases; the improvement has been in the direction of greater uniformity.

Nevertheless, it was evident that a further addition to the bacterial content might be occurring during the final packing, and the following figures for the agar count of powder from four factories (1) as received in bulk and (2) as finally packed, were taken for the first six months. It will be understood that these figures do not actually refer to the identical powder before and after packing; they represent the average counts of powder from each factory as examined on arrival of shipments, and the average counts of powder from each factory sampled after packing in the small containers.

TABLE 3.—Bacteria count per cubic centimeter (agar) before and after packing at 4 factories; first period of six months.

Factory.	Before packing.	After packing.
1.....	89	52
2.....	28	54
3.....	37	118
4.....	43	226
Average.....	49	113

It will be seen that, except in one case, a distinct increase in the number of organisms occurred, the average before packing being 49 per cubic centimeter and after packing 113 per cubic centimeter for this period.

In order to test this point by direct experiment, 8 samples were taken in duplicate before and after passing through the sifting and packing apparatus. These results may be quoted in full:

TABLE 4.—*Bacteria count of 8 samples in duplicate before and after packing.*

Sample.	Before packing.			After packing.		
	Agar.	Gelatin.		Agar.	Gelatin.	
		Liquid.	Non-liquid.		Liquid.	Non-liquid.
1.....	8	2	6	12	0	8
2.....	6	4	10	12	0	10
3.....	80	8	102	74	0	52
4.....	24	2	260	32	0	9
5.....	28	6	20	170	Liquefied.	Liquefied.
6.....	10	0	14	46	4	36
7.....	30	4	12	128	6	146
8.....	24	4	4	18	4	6
Average.....	26	4	54	62	2	38

The agar counts here show almost exactly the same proportional increase as the average over a long period quoted above; the gelatin shows a slight decrease, but obviously nothing can be deduced from this.

Figures have also been taken out for the second period of six months, showing the average agar counts before and after packing. These are as follows:

TABLE 5.—*Bacteria count per cubic centimeter (agar) before and after packing at 4 factories; second period of six months.*

Factory.	Before packing.	After packing.
1.....	28	132
2.....	30	54
3.....	153	39
4.....	37	55
Average.....	62	70

It will be seen from these figures that the increase in the number of organisms due to the final operations of sifting and packing is now negligible. This is doubtless due to greater care being exercised in the handling of the powder during these final processes, as a result of continuous bacteriological control, which keeps the necessity for the avoidance of contamination always before everyone concerned in the work.

IV. METHOD OF EXAMINATION.

The following procedure has been found suitable for carrying out routine examinations of milk powder. About 8 grams of powder are transferred by means of a sterile aluminum measuring spoon to a

tared sterile weighing bottle, having a capacity of about 100 cubic centimeters. The powder is then weighed, and eight times its weight of sterile water is added to it in the weighing bottle, allowance being made for the specific volume of the powder (0.76).

The powder and water having been well mixed by shaking, the bottle containing the mixture is placed in a water bath kept at 45° C. by means of a gas regulator, and held there for 10 to 15 minutes. This insures good reconstitution of the milk without running any risk of killing the bacteria. After reconstitution, the sample is again thoroughly shaken, and is then ready for examination. It has never been found necessary to dilute the reconstituted milk.

The following examinations are made:

0.5 cubic centimeters to each of three petri dishes to which are added agar, L. B. A., and gelatin, respectively.

1 cubic centimeter and 5 cubic centimeters to each of two MacConkey's lactose bile salt broths, with Durham's tubes.

10 cubic centimeters to each of three sterile test tubes for the *B. welchii* (*B. enteritidis-sporogenes*) test. These are Pasteurized at 80° C. for 15 minutes, and then incubated in the anaerobic apparatus described by McIntosh and Filde's (Medical Research Committee, National Health Insurance Report No. 12, 1917). All except the gelatin plates (22° C.) are incubated at 37° C. The agar and L. B. A. plates are counted after 48 hours' incubation, and the gelatin after 3 days. The anaerobic tubes are examined after 48 hours, and the MacConkey broth after 3 days' incubation.

This examination corresponds exactly, except as regards the quantities taken, with that ordinarily used for examining liquid milks, and to facilitate comparison with the latter, results are expressed per cubic centimeter of reconstituted milk.

V. THE VALUE OF MICROSCOPIC EXAMINATION OF RECONSTITUTED DRIED MILKS AS A CRITERION OF BACTERIAL PURITY.

Periodically, in the course of the routine examinations already referred to, examinations of the stained centrifugalized deposit have been made, as it appeared probable that this might prove a convenient method for the rapid assessment of the bacterial purity of a sample, and also of the purity of the original milk, especially with regard to the cellular content of the latter.

Experience, however, has shown that the picture presented by the stained centrifugalized deposit bears little or no relationship to the number of bacteria found by plating. This will readily be seen by a consideration of the examples in Table 6.

TABLE 6.—Comparison between centrifugalized deposit and agar count.

Description of centrifugalized deposit.	Agar count per cubic centimeter.
No bacteria observed.....	76
Numerous bacteria observed.....	30
Rather numerous bacteria.....	32
Scanty bacteria.....	422
No bacteria observed.....	654
Rather numerous bacteria.....	80

Even where the bacteria were described as "numerous," very few were present compared to the numbers which would be seen in any ordinary sample of fluid milk. By "numerous," in the case of dried milk, is meant one or two organisms per field under the one-twelfth-inch objective. By "scanty" is meant two or three organisms in the whole film after careful search. These numbers bear no comparison with those which one would expect to find in the deposit from 10 cubic centimeters of fluid milk, even of the very highest quality. The inference is that the majority of the organisms are actually destroyed, or rendered unstainable, in the process of drying.

This contention is not supported by Supplee and Ashbaugh (*Journal of Dairy Science*, V, No. 6, November, 1922, p. 570), who claim that Breed's method of counting bacteria by the microscope applied to reconstituted dried milk shows a reduction of about 50 per cent in the number of organisms counted in the original milk. Such a count would mean that every field of a film from the centrifugalized deposit from 10 cubic centimeters would contain very numerous organisms. It is true that, whereas Supplee and Ashbaugh's experiments were carried out on milk which was counted by Breed's method, and then immediately dried, reconstituted, and counted again, the centrifugalized deposits referred to here were made from reconstituted dried milk which had been manufactured some weeks, or even months, previously.

It is not easy to see, however, why this should affect the staining properties of bacteria. Until this paper of Supplee and Ashbaugh was published, it had always been assumed that the vast majority of the organisms in the original milk were destroyed or rendered unstainable. This is a point which would seem to repay further study as a matter of scientific interest, though from the practical point of view, the number of living bacteria in the finished product would appear to be the only thing that really matters.

Supplee and Ashbaugh suggest that dried milk might be graded on the basis of the bacterial content of the original milk. While it is agreed that a dried milk of high quality and low bacterial content can not be made from stale or heavily contaminated milk, the primary criterion of bacterial purity in dried milk must be the number and nature of the living organisms which it contains.

VI. SUMMARY AND CONCLUSIONS.

1. Careful study of possible sources of contamination, and their removal, has resulted in a very marked reduction of the bacterial content of dried milk during two seasons of manufacture.

2. The greatest increase in the number of bacteria after drying is liable to occur in the transportation of powder from the cylinders to the bulk packing plant. A further slight increase occurs on re-packing in small containers, but this has now been reduced to almost negligible proportions.

3. A technique almost identical with that employed for the bacteriological examination of wet milk has been found suitable for the routine examination of dried milk.

4. The number of bacteria seen in stained centrifugalized deposits of reconstituted dried milk bears no relationship to the plate counts nor, apparently, to the number of bacteria in the original milk. Investigation of the number and nature of living bacteria in the final product is regarded as the most useful method of judging the purity of dried milk, and of checking recontamination during manufacture.

Chairman PAGE. Mr. Jephcott is also going to give us a talk on "Fat in commercial casein."

FAT IN COMMERCIAL CASEIN.

HARRY JEPHCOTT, M. Sc., F. I. C., Glaxo Laboratories, London; and NORMAN RATCLIFFE, F. I. C., Glaxo Laboratories, Hamilton, New Zealand.

Users of casein, both rennet and acid, have long recognized that the presence of fat has a detrimental effect upon the quality of their products.

Referring to the influence of fat upon casein glues, the first report of the adhesives research committee (p. 9) states:

(1) The strength of the cement, as measured by the aircraft inspection department's tests, diminished markedly with increase of the fat content.

(2) The shear strength for plywood similarly diminished with increase of fat.

(3) The waterproofness is not appreciably affected by moderate amounts of fat.

Similar effects are known in the manufacture of hardened casein products from rennet casein. A high-fat casein fails to bind well, and an inferior article results. For these reasons manufacturers usually specify a limit of fat, and the production of caseins of low fat content becomes a matter of high economic importance.

Investigation has been made into factors controlling the proportion of fat in casein, and into the extent to which the fat in the separated milk is retained by the casein precipitated from it.

DIVISION OF FAT BETWEEN CASEIN AND WHEY.

In order to determine what proportion of the fat was retained by the casein, a series of samples were drawn from various factories preparing rennet casein, and the following figures were carefully determined:

Volume of separated milk.

Fat in separated milk.

Volume of whey.

Fat in whey.

Volume of wash water.

Fat in wash water.

Weight of anhydrous casein produced.

Fat in anhydrous casein.

From these figures the proportion of the total fat in casein, whey, and wash water has been calculated, and the whole results are set out in the following tables:

TABLE 1.—*Quantities.*

Factory.	Separated milk.	Whey.	Wash water.	Casein (anhydrous).
	<i>Gallons.</i>	<i>Gallons.</i>	<i>Gallons.</i>	<i>Pounds.</i>
1.....	780	700	120	245
2.....	616	570	120	193
3.....	800	700	150	251
4.....	550	500	.....	177
5.....	520	470	.....	164
6.....	480	420	.....	163
7.....	630	555	100	198
8.....	550	.....	.....	173

TABLE 2.—*Fat percentages.*

Factory.	Separated milk.	Whey.	Wash water.	Casein (anhydrous).
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
1.....	0.156	0.094	.....	2.25
2.....	.090	.047	0.004	1.52
3.....	.229	.084	.019	5.39
4.....	.119	.0565	.....	2.15
5.....	.253	.101	.....	5.38
6.....	.265	.098	.....	5.10
7.....	.133	.030	.0067	2.57
8.....	.124	.....	.....	2.15

TABLE 3.—*Total fat in pounds and percentage distribution.*

Factory.	Separated milk.	Whey.	Wash water.	Casein (anhydrous).	Total.	Whey.	Wash water.	Casein.	Total.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
1.....	12.56	6.70	(0.05)	5.51	12.26	53.4	(0.4)	43.9	97.7
2.....	5.72	2.72	.04	2.93	5.70	47.5	.9	51.2	99.6
3.....	18.91	5.99	.29	13.52	19.80	31.6	1.5	71.5	104.6
4.....	6.76	2.88	(.05)	3.80	6.73	42.6	(.7)	56.2	99.5
5.....	13.59	4.83	(.05)	8.82	13.70	35.5	(.4)	64.9	100.8
6.....	13.17	4.99	(.05)	8.31	13.35	37.9	(.4)	63.1	101.4
7.....	8.66	3.39	.07	50.9	8.56	39.2	.8	58.8	98.8
8.....	7.05	.....	.....	3.72	.....	.....	.....	52.8	.....

In Table 3 the figures given in parentheses for wash water are taken as an average, and were not determined.

In considering the variation between the total fat found in the whey, wash water, and casein, allowance needs to be made for some slight inaccuracy in measuring the volumes in large vats. These measurements were probably subject to an error of at least 1 per cent. The determinations of fat were done in all cases by the Werner-Schmidt method, and the results confirm the authors' views that for casein analysis, as for dried milk, it is the only satisfactory method. The details of the method will be discussed later.

The vat taken at factory No. 3 was abnormal. At the time of adding rennet the acidity of the milk was too high (0.28 per cent),

and considerable cheddaring occurred during the "cooking" process, with the result that the whey did not leave the curd freely. The higher results in this instance are probably due to the same cause, since the casein tended to be uneven, and it is possible that the sample was not perfectly representative of the bulk.

Omitting this abnormal case, it is seen that from 44 to 64 per cent of the fat remained in the casein, with an average of 55.8 per cent.

Little fat is removed by the wash water, and it is evident that the amount of fat in the casein depends primarily upon the fat content of the separated milk. In the instances given, this varied between wide limits, but there was no indication that a larger proportion of the total fat was carried off in the whey in separated milks of high fat content. The whey from the two separated milks containing the highest fat (Nos. 5 and 6) contained about 37 per cent of the total, whilst those from the two lowest contained 45 per cent of the total.

With a view to ascertaining whether tenderness of the curd and early cutting influence the proportion of fat in the casein, three experiments were carried out in the laboratory. Three quantities, each of 5 liters, taken from the same vat of separated milk were warmed to the same temperature, and equal quantities of rennet were added. The first was cut after 12 minutes, whilst the curd was still very tender; the second after 18 minutes, and the third after 24 minutes. In each case the casein was subjected to precisely the same cooking process, and identical quantities of wash water were used. The casein was then dried and the percentage of fat in each sample was determined. The fat is expressed upon the anhydrous casein.

TABLE 4.—*Influence of time on fat determination.*

Number.	Time.	Fat.
	Minutes.	Per cent.
1.....	12	2.19
2.....	18	2.42
3.....	24	2.52

It is evident that the firmness of the curd considerably affects the readiness with which the fat is retained. Sample No. 3 contains some 15 per cent more than sample No. 1.

DETERMINATION OF FAT IN CASEIN.

Laboratory practice in the estimation of fat in casein varies considerably. In the earlier papers, from the Dairy Division, United States Department of Agriculture, Soxhlet extraction was invariably employed; but Shaw, in a paper dated June, 1920, remarks that the Rose-Gottlieb method gives results higher than those obtained by the extraction method.

Gangolli and Meldrum, a little later, draw attention to the discrepancy between their determinations and those made at the Imperial Institute, London. They suggest a new method in which

casein is dissolved in half-normal caustic soda solution in a separating funnel, and the fat shaken out with ether.

In general, there has been some failure to recognize that rennet and acid caseins differ markedly in their solubility in alkali, and methods are referred to and suggested as generally applicable to casein when they have only been tried upon acid caseins, and which if applied to rennet casein, would fail entirely.

With a view to clearing up some of these discrepancies, a critical study of the methods as applied to both rennet and acid caseins has been made. The methods employed were as follows:

(1) *Soxhlet* extraction with dry ether, until nothing more could be extracted; 5 grams of casein used in each case.

(2) *Rose-Gottlieb*, using 1 gram casein; the fat first extracted, being reextracted with petroleum ether, and the difference taken as fat.

(3) *Gangolli and Meldrum* method: 1 gram 60-mesh casein dissolved in 15 cubic centimeters, 0.5 normal NaOH in a 100 cubic centimeter separating funnel, and the fat shaken out with ether.

(4) *Werner-Schmidt*: 1 gram casein, 8 cubic centimeters water, 10 cubic centimeters concentrated HCl, dissolved by boiling for 3 minutes, and the solution well shaken out with ether; the fat first extracted, reextracted with petroleum ether, and the difference taken as fat.

TABLE 5.—*Fat in casein, by four methods.*

RENNET CASEIN.

Mesh.	20 to 40	40 to 60	60 to 80	80 to 100	100
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Soxhlet extraction.....	0.78	1.03	1.34	1.87	2.53
Werner-Schmidt.....	{ 5.6 6.0	{ 5.8 5.8	{ 5.8 5.7	{ 6.0 5.7	{ 6.2 6.4
Rose-Gottlieb.....	{ .44 .56				
Gangolli and Meldrum.....			{ .22 .88		

LACTIC CASEIN.

	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Soxhlet extraction.....	0.27	0.34	0.45	0.58	0.84
Werner-Schmidt.....	{ 2.25 2.25	{ 2.25 2.36	{ 2.36 2.36	{ 2.55 2.55	{ 2.44 2.44
Rose-Gottlieb.....	{ 2.0 2.1				{ 2.2 2.4
Gangolli and Meldrum.....			{ .34 .34		

It will be observed that the direct ether extraction only takes out a relatively low percentage of the total fat even when the casein is in very fine powder, and that the actual amount of fat extracted varies with the fineness of the casein. This is what would have been anticipated upon theoretical grounds. There is no reason to believe that the fat is other than evenly distributed throughout the casein, the particles of which are exceedingly hard, and it is not unreasonable to assume that the ether fails to penetrate the particles; consequently only the fat at or near the surface of the particles is extracted.

The method recommended by Gangolli and Meldrum also fails to extract more than a small proportion of the total fat. Rennet casein is insoluble in caustic soda of the strength suggested, and it is probable that these workers were concerned with acid casein only. With casein of this latter type the method gives better results and is certainly much easier to carry out. Even in such cases, however, the results are far from indicating the correct state of affairs.

The Rose-Gottlieb method fails entirely with rennet casein for the same reason as that of Gangolli and Meldrum, i. e., the casein is not dissolved. With acid caseins good results are obtained provided that the casein is in such fine state of division as will facilitate its complete solution in the ammonia.

With the Werner-Schmidt method results are obtained which are in excellent agreement with one another, and generally consistent, irrespective of the fineness of the casein. There appears a tendency for slightly high results where the casein is very finely ground, for some reason not apparent.

A sample of finely divided casein, which had been treated with alcohol and ether after repeated washings with dilute acid, was available in this laboratory, and was believed to be free of fat. Repeated determination on this sample, by the Werner-Schmidt method, gave nil results in every case. Under the conditions described, the action of the acid upon casein is not, therefore, to produce degradation products which are soluble in both ether and petroleum ether. Moreover, to this specially purified casein was added a known percentage of anhydrous butterfat, and by the Werner-Schmidt method the theoretical quantity was extracted.

A critical study of the Werner-Schmidt method has been made (in connection with the analysis of dried milk, for which the method is excellent), and certain precautions have proved to be necessary to insure results of high accuracy.

In extracting the acid liquor with ether, it is better first to add about 30 cubic centimeters and blow off without agitation. The bulk of the fat is floating on the acid liquor after boiling. It dissolves at once in the ether, and is removed without risk of loss through imperfectly fitting stoppers when agitating.

After distilling, the ether flasks should be dried at 100° C. for one hour, with occasional blowing out of ether vapor by means of hand bellows.

Flasks must remain in a desiccator until perfectly cold, and be lifted out by the rim, using the thumb and forefinger only when placing on the balance. The taking hold of the flasks with the hand will often cause an error of several milligrams and involve an error of 0.5 per cent (on the ash) or even more, in exceptional cases.

The fat should always be extracted from the flask with petroleum ether, and the flask again dried for one hour, cooled, and weighed with the same precautions mentioned above, and the difference in the weights taken as fat.

SUMMARY.

1. Rennet casein retains from 50 to 60 per cent of the fat in the separated milk from which it is prepared.

2. The fat content of the separated milk is the prime factor in controlling the fat in the casein, although other factors affect it slightly.

3. Soxhlet extraction is useless as a method of determining fat in casein.

4. Methods of fat determination dependent upon solution of the casein in alkali are unsatisfactory, since rennet casein will not readily dissolve in alkali.

5. The Werner-Schmidt method is an accurate method for all varieties of casein.

Chairman PAGE. There are two papers added to the program to be given by Doctor Sato, professor of Imperial University of Japan, but he is not here, so they will be read by title and afterwards published.

Are there any other points to be taken up, or any questions?

Doctor HOLM. I would like to hear again from Doctor Hauser, who is studying the low moisture content of milk powders. In one of the sessions yesterday he gave an excellent paper on the determination of the solubility of milk powder by thermal methods.

(Doctor Hauser gave the paper that he read in session 22.)

Doctor HOLM. I am sorry Mr. Leighton of the Dairy Division, of Washington, is not present to give his paper, which is of special interest in connection with the first paper given. I think in Doctor Miyawaki's paper there was one fact concerning condensed milk that was not brought out—that was the temperature of forewarming the milk before it goes into the condensed product. I think I have this straight. If I have not, Mr. Leighton can add something when I get back. I think they found that the temperature of forewarming had much to do with the thickening of condensed milk. They found that if you forewarmed at 85° C., or at 120° C., you can prevent thickening entirely, and the product may be kept over a long period of time without having it jell; 110° works satisfactorily, and long heating at boiling temperature of water will also do it, but it has to be prolonged a very long time. The optimum temperature of forewarming for producing rapid gelatinization of the product is 95° C. That was the sum and substance of the paper Mr. Leighton was to present, and I thought it would be of special interest in regard to the first paper on the program.

Chairman PAGE. I am very glad you gave us that information. If there is nothing further, a motion to adjourn will be in order.

(Adjournment.)

(Papers read by title):

FACTORS INFLUENCING THE HEAT COAGULATION OF MILK AND THE THICKENING OF CONDENSED MILK.

ALAN LEIGHTON and EDGAR F. DEYSHER, research laboratories, Dairy Division,
United States Department of Agriculture.

It is the intention of this paper, while discussing several factors which influence the coagulation of milk by heat, to emphasize particularly the effect of time and temperature of forewarming on the stability toward heat of evaporated and condensed milks. Information of value in formulating a theory of heat coagulation will also be given.

The work here described has all been done with mixed skim milk from the United States Department of Agriculture farm at Beltsville, Md. The relationships found have not yet been checked by comparison with milks from other sources, but the data, except for that concerning the lower forewarming temperatures, have been obtained in almost daily experiments, during a period of two or more years. The term evaporated milk here signifies a concentrated product, while condensed milk means the concentrated milk to which sucrose has been added.

Before discussing the stability toward heat of both evaporated and condensed milks, we should point out that Leighton and Mudge (1) have advanced considerable evidence showing that in the heat coagu-

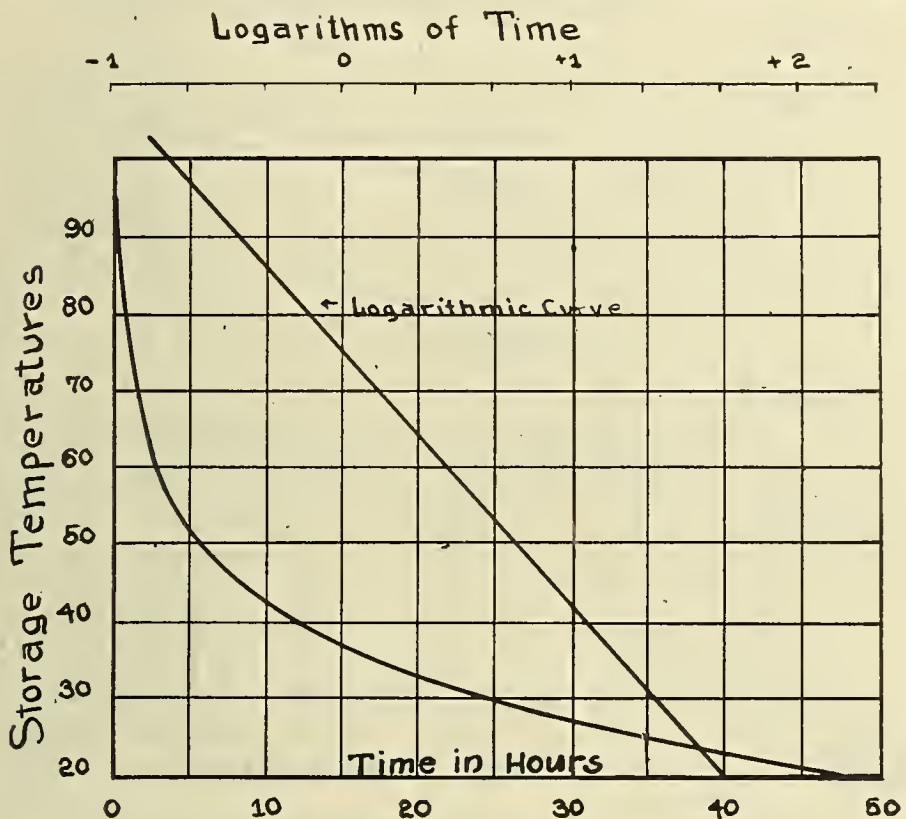


FIG. 1.—Time required to produce coagulation in condensed milk samples stored at different temperatures.

lation of milk the calcium and magnesium of the milk are precipitated as phosphates and citrates and that the reaction is endothermic. They arrive at these conclusions from the fact that if an artificial serum be made up according to Van Slyke's formula (2), the calcium and magnesium are precipitated by heat with marked absorption of heat at the moment of coagulation. They also infer that the protein calcium is concerned in this reaction, since the amount of the heat absorption obtained with artificial serum can not be made equal to that obtained from milk unless there is present in the serum an added amount of calcium equivalent to that which is normally bound with the protein of milk. Evidence is also advanced showing that the mechanism of the reaction which causes the thickening of condensed

milks at ordinary temperatures is essentially the same as that of the coagulation of both evaporated and condensed milk at high temperatures. This is seen from the following facts: When either evaporated or condensed milk is coagulated at high temperatures, the endothermic reaction can be shown to take place. If we record the time it takes to produce thickening in condensed milk at the widely different temperatures under consideration, and draw a curve plotting time of storage against temperature of storage (Fig. 1), we see that we get a smooth curve, indicating that we have the same reaction throughout.

Fig. 2-A.

Fig. 2-B.

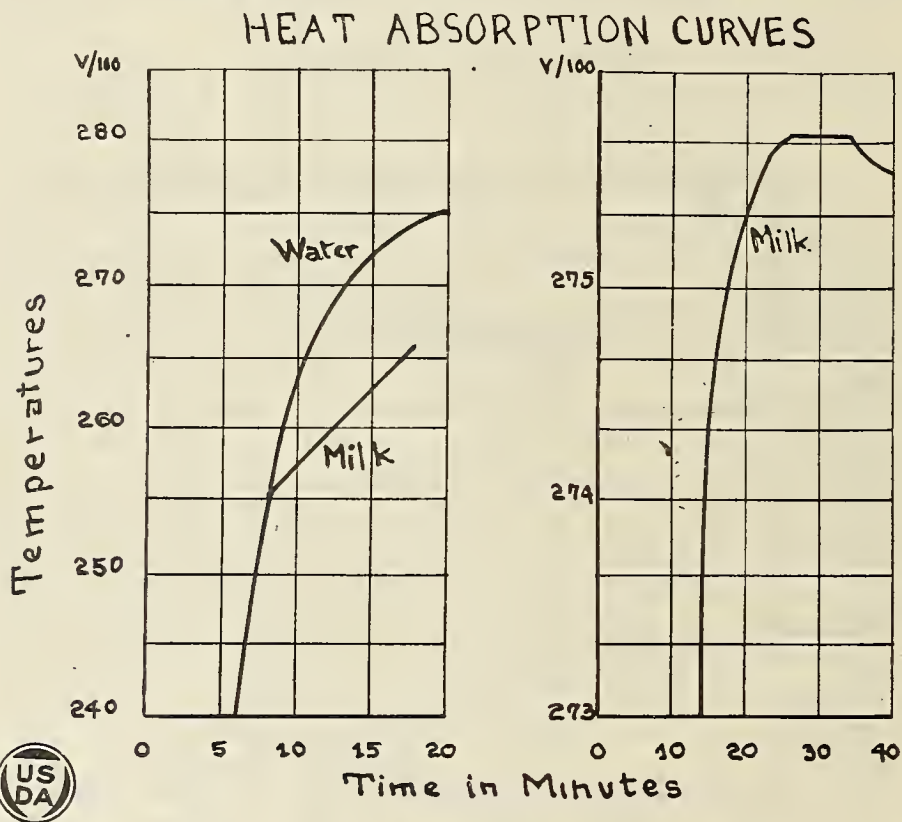


FIG. 2.—Curves showing heat absorption taking place when milk is coagulated by heat. A. When coagulation takes place before the milk temperature has reached that of the oil bath. B. When coagulation takes place after the oil bath temperature has been reached.

Further, if we take these figures of the thickening in condensed milk and plot logarithms of time against temperature, we get a straight line. By continuing this straight line curve, we find the time of coagulation corresponding to 95° of temperature to be seven and one-half minutes, about equal to the time that is actually required to thicken the milk at 95° . This is the temperature at which heat absorption begins on our curves, as will be shown later. In other words, the precipitation of calcium and magnesium takes place at low as well as at high temperatures.

The endothermic nature of the coagulation reaction may be demonstrated in one of two ways. We may choose so high a temperature

in a constant-temperature oil bath that if an autoclave containing milk be immersed, the milk will coagulate before the temperature of the bath is reached. If we measure the temperature of the milk periodically, let us say every minute, we may plot a curve of temperature against time. The upper part of such a curve obtained with normal skim milk is given in Figure 2-A.

If, for comparison, we also plot a curve of the temperatures attained when water instead of milk is present in the autoclave, we note that there is a distinct flattening of the milk curve. Repeated tests have shown that the flattening of the curve takes place coincidentally with coagulation. Or, we can choose a bath temperature

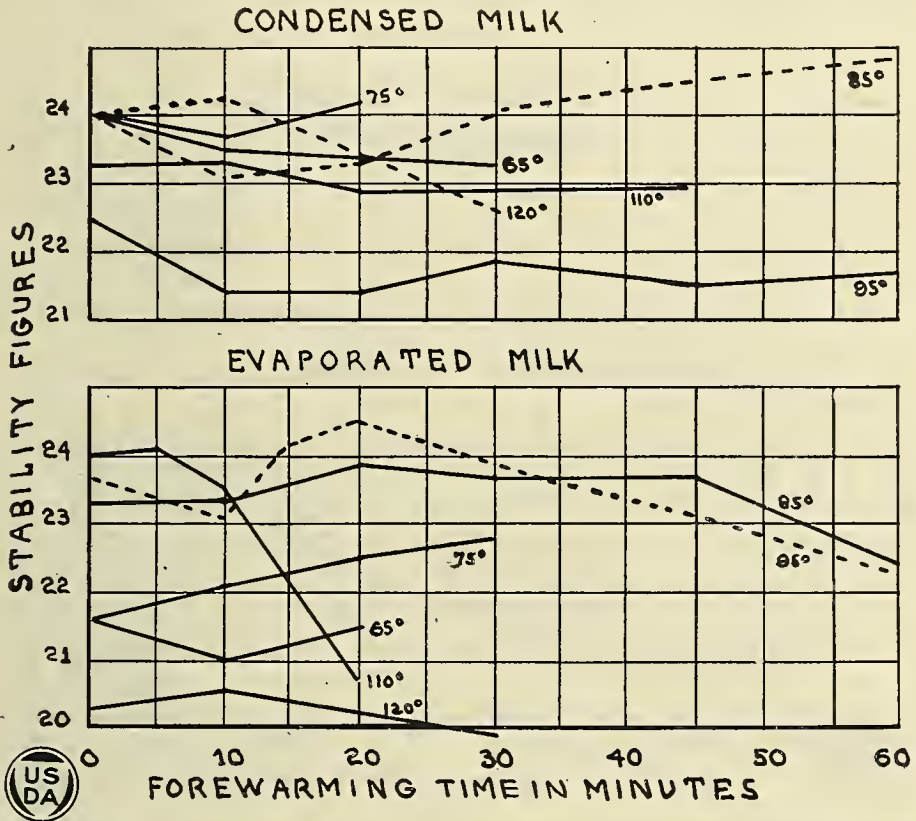


FIG. 3.—Effect of forewarming time upon the stability toward heat of both condensed and evaporated milks.

sufficiently low for the milk to have time to reach the temperature of the oil bath before coagulation takes place. In this case (Fig. 2-B), we note that there is a slight temperature drop which occurs simultaneously with the appearance of a visible curd. For normal milks this drop may be from 0.05° to 1.5° . The lower value is the more common. In these experiments a steel autoclave containing about 125 cubic centimeters of milk was employed. The temperatures were measured with a five-junction copper-constantan thermocouple and a Leed's-Northrup type K potentiometer.

If we choose a bath temperature of about 130° C., the evaporated and condensed milks coagulate rapidly, and we have favorable conditions for determining the stability of these milks by measuring the heat absorption. They curdle too quickly to enable us to determine

the precise instant at which coagulation starts. Since, however, the amount of heat absorption will be proportional to the degree of coagulation at a given time, the temperature attained within the autoclave at some suitable arbitrary time will serve as an indication of the stability of the milk. In this work the stability of the majority of the condensed and evaporated milks has been judged by this method, choosing nine minutes as the arbitrary time of heating. These values have been checked, in the case of evaporated milks, by a series of tests in the pilot sterilizer and with the condensed milks by some "accelerated" storage tests at 50° C.

EFFECT OF FOREWARMING TEMPERATURE

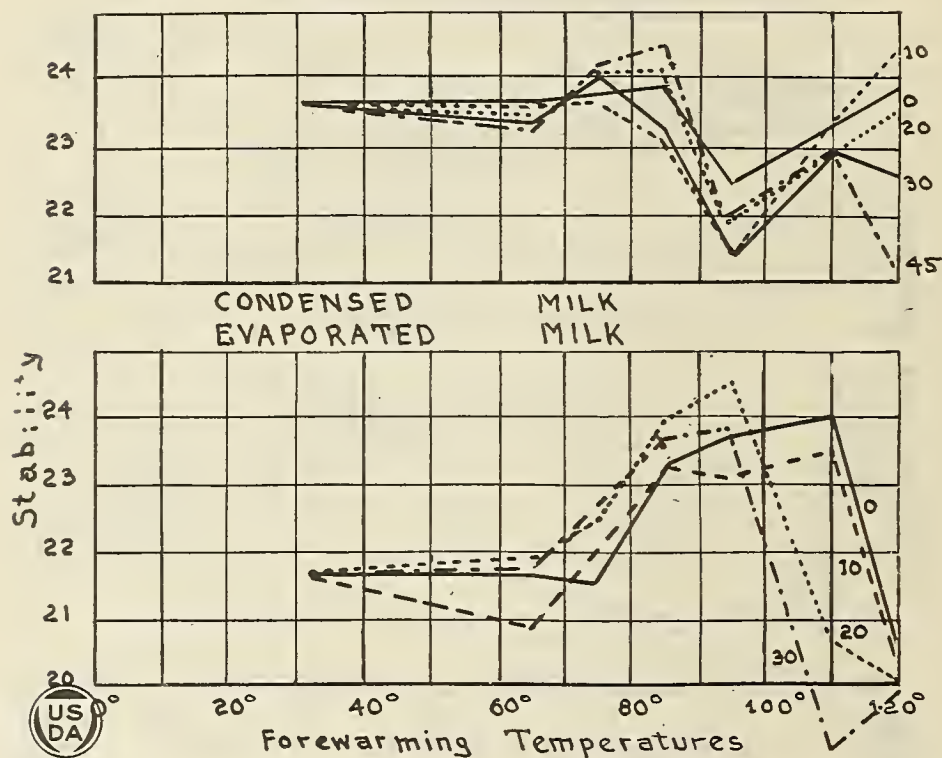


FIG. 4.—Effect of forewarming temperature upon the stability toward heat of both condensed and evaporated milks.

The condensed milks made up for experimental purposes were concentrated to have 48 per cent sucrose, 20 per cent milk solids not fat and 32 per cent water. In order that there might be a direct relation between the condensed and evaporated milks in the heat absorption tests, the evaporated milks were concentrated to have the same ratio of milk solids not fat to water as found in the condensed milk. The evaporated milk therefore contained 38.4 per cent milk solids not fat and 61.6 per cent of water. In the sterilizer tests the usual 18 per cent milk solids not fat product was employed.

We may now show (Fig. 3) the effect of forewarming upon the stability of condensed and evaporated milks toward heat. The abscissa is the time of forewarming, the ordinate is the temperature

attained in nine minutes when the milks were placed in the autoclave and immersed in an oil bath at a temperature of 130° C. From the fact that the curve for each forewarming temperature, with one or two exceptions, seems to lie in its individual zone, it becomes apparent at once that the temperature of forewarming is the major factor in determining the resistance to heat of both evaporated and condensed milks. The time of forewarming is not so important, although it must not be neglected.

From the condensed milk curves, we see that a 65° forewarming slightly stabilizes the finished product over the unforewarmed material. At 75° there is a slight increase also, while at 85° a decrease sets in which is very marked at 95°. An increased stability follows upon forewarming at 110° and 120°.

Effect of SUGAR

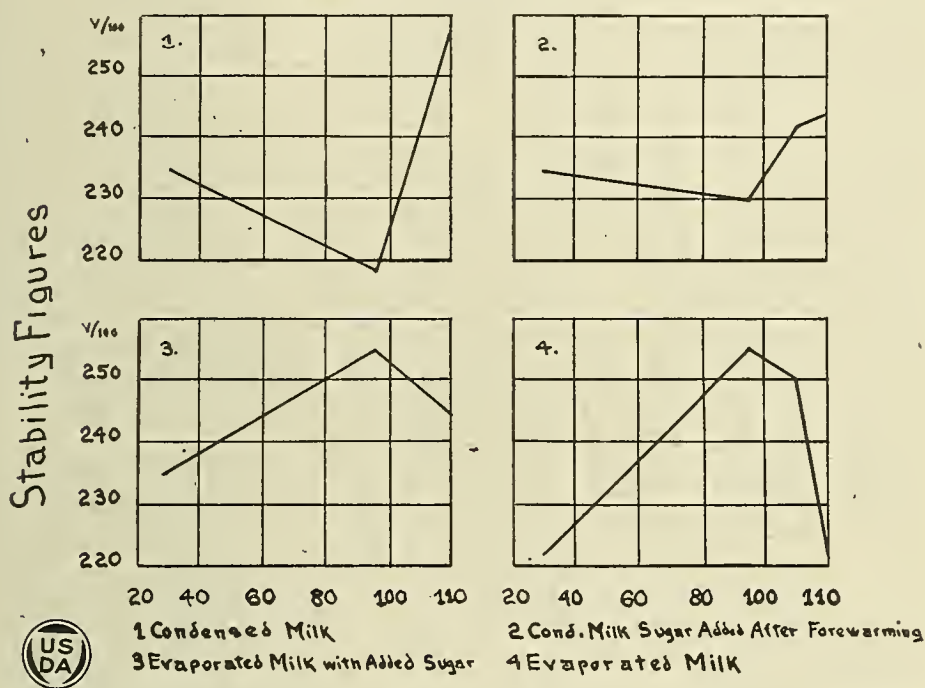


FIG. 5.—Effect of cane sugar upon the stability toward heat of concentrated milks.

The curves for the evaporated milks are practically the reverse of those for the condensed milks. The 65° forewarmed material is slightly less stable than the unforewarmed product. Stability then increases up through a 95° forewarming, where it is near a maximum, and decreases at 110° and 120°.

The relationships of the forewarming temperatures can perhaps be better shown if we combine this data in a curve in which we plot forewarming temperature against stability. (Fig. 4.)

It is evident that the condensed and evaporated milk curves are almost the reverse, or mirror images, of one another. The only factor that can account for the difference between the milks beside the diluting effect of the sugar is its chemical effect. To investigate this chemical effect of the sugar, one series of condensed milks was prepared in the usual way. In a second series the cane sugar was

not added until after forewarming; in a third the sugar was added after evaporation. The fourth or control series was an evaporated milk. The stability of these samples was determined for unforè-warmed, and for 95°, 110°, and 120° forewarmings. The curves are given in Figure 5. It becomes at once apparent that the sugar exerts its effect in the forewarming process, in the evaporating process, and the coagulating process. Its effect is to unstabilize the 95° forewarmed product, and to stabilize the 120° material.

Now it has been stated that the heat absorption incident to coagulation comes from the precipitation of calcium and magnesium. Since cane sugar can react with calcium, and since some calcium and magnesium salts dissolve in sugar solution, it follows that we can look for the sugar effect in its action upon the metallic salts of the milk.

Since it is apparent that the temperature of forewarming is such an important factor in milk condensing, it is probable that a salt equilibrium is established depending on temperature. This theory is strengthened by a few rough experiments upon milk, passed over the zeolite water softener kindly furnished these laboratories by the Permutit Co., of New York City. This material would presumably substitute sodium for the calcium and magnesium of the milk serum. Because the pores of the permutit easily become clogged with the protein matter, it is almost impossible to regulate the degree of this substitution. However, one fact seems to be very definitely established, namely, that the treatment results in an evaporated milk which is less stable toward heat than is an untreated, unforèwarmed sample. If the milk is forewarmed after treatment, however, its stability is fully comparable with that of a forewarmed milk that has not been treated with the softener. The salt equilibrium is evidently reestablished by the heat treatment.

In considering the effect of forewarming upon the salt equilibrium of milk, it seemed probable that osmotic pressure measurements might throw some light on these changes. The indirect freezing-point method seemed the best to use for determining this. No difference was found in the freezing points of milks forewarmed at the different temperatures above 65°. The 65° milk has a freezing point equal to that of the unforèwarmed milk; the 85°, 95°, 110°, and 120° milks have a freezing point 0.01 higher than normal milk. One one-hundredth of a degree is about 2 per cent of the total depression. This would indicate, then, that a change of about 2 per cent in the total number of ions and molecules present in the original milk is brought about by forewarming. The results throw no light on our problem, however.

It has also been pointed out by Doctor Holm of these laboratories, in an unpublished report, that usually the forewarming of a normal milk makes the unconcentrated milk less stable toward heat, but if the milk is concentrated after having been forewarmed to about 95° for 10 minutes, apparently a point is always reached when in the concentrated milk the forewarmed product becomes more stable than the unforèwarmed. It is of interest to note that the forewarmed milks have an equal stability at a concentration of about 12 to 13 per cent milk solids not fat. More recent work upon the forewarming of normal milk seems to show that the effect of 10-minute

forewarming at different temperatures up to 120° is to render the unconcentrated milk less stable to heat in the sterilizer, but that there are no appreciable differences between the milks forewarmed at 65° , 75° , 85° , 95° , 100° , 110° , and 120° . This is in agreement with the osmotic pressure measurements, but again no light is thrown upon the effect of forewarming on the salt equilibrium. It is apparent that the changes brought about by forewarming are very slight and that their effect on the stability of milks toward heat can not be demonstrated without concentration. The determination of these changes is a problem yet to be solved.

If we are to consider other factors influencing the stability of evaporated and condensed milk toward heat, we must, of course, mention acidity, concentration, and the "salt balance." We have no detailed information at this time to report on these factors. Sommer and Hart (3) show that there is apparently an optimum ratio between the calcium and magnesium ions and the phosphate and citrate ions favorable to maximum stability in normal milk. In a later paper Sommer claims the same to be true for evaporated milks. Rogers, Deysher, and Evans (4) have shown, however, that the value of the salt balance, as determined analytically in a normal milk, is not an indication of the heat stability of the evaporated milk made from this normal sample. Their conclusion is that the salt balance of normal milk, while a factor, is by no means the controlling factor, since milks of the same salt balance reacted differently to heat. We can not take Sommer's results as conclusive until we know a little more regarding the effect of the different ions upon the precipitation of casein. It is clearly pointed out by Bancroft (5) in his book that whether a colloid be negative or positive, it may absorb both negative and positive ions. If the colloid is negative, negative ions stabilize it, while the positive ions unstabilize it, and vice versa. This means that the results will vary greatly with the nature of the calcium salt added. In our opinion Sommer has given this point too little consideration.

To summarize now what we know of heat coagulation:

When coagulation takes place, there is a precipitation of the calcium and magnesium as phosphates and citrates, with the absorption of heat.

The greater the heat-resisting properties of the milk, the less is the amount and speed of this precipitation.

Forewarming influences the stability of both evaporated and condensed milks.

The temperature of forewarming is the most important factor. Time is of less importance.

The cane sugar of condensed milk modifies the effects of forewarming.

It seems possible that a salt equilibrium is established by the forewarming which varies with the temperature. Sugar may affect this equilibrium by reacting with the metals or by dissolving some otherwise insoluble calcium or magnesium salts.

The effect of forewarming upon normal milk is to unstabilize it. The effect on stability of the different forewarming temperatures discussed in this paper is too small to be measured in the sterilizer

without concentration although it shows up markedly in the concentrated milk.

There is a change in the osmotic pressure of normal milks with forewarming, but the degree of this change is independent of the temperature.

As would be expected, the concentration of the serum and of the protein is a stability factor. This has been demonstrated by other authors.

Without further information it is almost impossible to draw up an adequate theory of coagulation which will take into account all of these facts. There are a number of possibilities as to the nature of the reaction. It may be that the protein itself is altered by the heat, by reaction with the salts, or even by reaction with the water present. Or, as seems more likely to the authors, the reaction may be colloidal in character and the actual curdling may be due to the ionic equilibrium changes brought about by reactions of the milk salts. A combination of the two is of course within reason.

We must point out that since the casein of milk is on the alkaline side of its iso-electric point, it will be stabilized by the negative ions and unstabilized by the positive ions. Because of the specific adsorptive power of casein, we will expect the different salts to act differently, for instance, calcium chloride in certain instances may have a much greater precipitating power than will calcium phosphate. From these facts and from the fact that calcium and magnesium are precipitated when milk coagulates, we believe that a careful investigation of the equilibrium of the salts of milk will go far toward explaining the heat coagulation phenomena. This seems even more apparent when we consider that the calcium and magnesium are probably present in milk: (1) in combination with the protein; (2) as ions or in un-ionized molecules; and (3) in insoluble form. It is evident that there is abundant opportunity for heat to change the equilibrium.

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SEDIMENTS OF EVAPORATED MILK.

MASAYOSHI SATO, D. Sc., Hokkaido Imperial University, Sapporo, Japan.

The writer examined Alpine milk (one kind of evaporated milk), which had been preserved over two years as a specimen in the specimen room of the zootechnical department of the Hokkaido Imperial University.

The can was opened and its bottom was found covered with some small, white particles that appeared like gravel, but took no form of a crystalloid. At first sight it could be recognized that this material was different from the coagulated albumen often found in condensed milk. After the particles had been taken out and washed several times with cold water and then with ether, a qualitative test showed that calcium, magnesium, and phosphorus were present therein. It was further ascertained by a quantitative test that these substances were composed of tricalcium phosphate $\text{Ca}_3(\text{PO}_4)_2$, magnesium phosphate $\text{Mg}_3(\text{PO}_4)_2$, and tricalcium citrate $\text{Ca}_3(\text{C}_6\text{H}_5\text{O}_7)_2$.

THE CRYSTALS FOUND IN SWEETENED CONDENSED MILK.

MASAYOSHI SATO, D. Sc., Hokkaido Imperial University, Sapporo, Japan.

With crystals from samples of commercial sweetened condensed milk the writer made investigation, first, of their physical, and then of their chemical and crystallographical, nature, and obtained the following results:

The milk took the aspect of two different types of crystals under microscopic examination, one taking a bush-like form of needles and their masses, and the other taking a trapezoidal form. The former on analysis was found to be mostly tricalcium citrate $(\text{Ca}_3(\text{C}_6\text{H}_5\text{O}_7)_2)$; and sometimes the crystals of tyrosin were found therewith. There were also present tricalcium phosphate $(\text{Ca}_3(\text{PO}_4)_2)$ and magnesium phosphate $(\text{Mg}_3(\text{PO}_4)_2)$ in an amorphous condition, and the crystals of leucin and cystin were also observed.

The crystal in a trapezoidal form was found to be the same as that of milk sugar in its chemical nature, the crystalloid having doma but generally lacking the M face and M' face that are found in the pure milk sugar.

The combination of those crystalloids having doma was as follows:

a=(100)	a'=(100)
q=(011)	q'=(011)
m=(012)	m'=(012)
b=(010)	b'=(010)

These crystalloids seemed to belong to the monoclinic system. Such crystals could not be obtained by heating and condensing pure milk-sugar solution milk, and milk serum; but when the milk sugar was crystallized in the cane-sugar fluid, crystals similar to those of the trapezoidal form lacking the M' face found in the condensed milk, could be observed therein.

SESSION 25. CONTROL OF THE QUALITY OF MILK.

Honorary chairman, Dr. S. ORLA-JENSEN, professor of technical biochemistry in the Royal Technical College, Copenhagen, Denmark.

Chairman, Dr. C. L. ROADHOUSE, professor of dairy industry, University of California.

Secretary, J. S. MOORE, professor of dairy husbandry, Mississippi Agricultural and Mechanical College.

ONONDAGA HOTEL.

Syracuse, N. Y., Wednesday, October 10, 1923—9.30 a. m.

Chairman ROADHOUSE. The meeting will please come to order.

We are gathered this morning for the twenty-fifth session of the congress. We have with us as honorary chairman, Dr. S. Orla-Jensen, professor of technical biochemistry, Royal Technical College, Copenhagen, Denmark. [Applause.]

The control of the quality of milk, our subject for this morning, is one of recent development; the greater progress along this line has been made in the last 20 years. We have as our first speaker Dr. W. H. Price, of the Detroit Creamery Co. Is Doctor Price in the room? He is not.

We will take up the second subject, which is "Milk administration in England and Wales." by J. N. Beckett, principal, and J. M. Hamill, medical officer, foods department, English Ministry of Health. Doctor Hamill will read the paper. [Applause.]

MILK ADMINISTRATION IN ENGLAND AND WALES.

J. N. BECKETT and JOHN MOLYNEAUX HAMILL, O. B. E., M. D., D. Sc., Ministry of Health, London.

CENTRAL AND LOCAL AUTHORITIES.

In dealing with the subject of milk administration in England and Wales it is necessary to begin with a brief description of the central and local authorities which take part in the administration.

The central authority mostly concerned is the Ministry of Health (who have succeeded to the powers formerly exercised by the local government board), but the Ministry of Agriculture and Fisheries are necessarily interested in all matters relating to dairying, and they are, in fact, always consulted by the Ministry of Health in all important matters, whether or not their formal concurrence is required by law.

The principal functions of the Ministry of Health, acting either alone or in conjunction with the Ministry of Agriculture and Fisheries, are the initiation of legislation, and the issue of regulations and orders of general application. Apart from this, the ministry exercise considerable influence over the action of local authorities by the issue of circulars and memoranda, and by giving advice to individual authorities which ask for guidance on specific questions.

The actual work of administration is carried out by local authorities, acting usually through their medical officer of health and his staff. The authorities are generally bound by the provisions of acts of Parliament and the regulations and orders of the Ministry of Health; but within these limits they exercise their own discretion, subject only to such control as may be imposed by decisions of the courts of law. The success of any elaborate scheme of legislation depends, therefore, on the zeal and discretion of the local authorities which administer it; and in particular on the care with which inspections are carried out and the attention given to the more important matters.

Before going further, it is perhaps desirable to say a few words as to the classes of local authorities concerned. The largest authorities are the councils of administrative counties and county boroughs, the latter being the larger boroughs (generally having a population over 50,000) whose councils possess all the powers of a county council within the borough, as well as those of a town council. There are 63 administrative counties and 82 county boroughs in England and Wales.

Every administrative county consists of a number of sanitary districts known as boroughs, urban districts, and rural districts, and most of the detailed sanitary work of the country is in the hands of the councils of these areas and of the county boroughs. The number of such districts is about 1,700. The London area ranks as a county for administrative purposes and is divided into 29 sanitary districts known as metropolitan boroughs.

The official control of milk falls naturally into two categories, the one concerned with the prevention of adulteration, the other with cleanliness and hygienic conditions.

ADULTERATION.

The local authorities concerned with the prevention of the adulteration of milk and other foods are the county councils and the councils of county boroughs, metropolitan boroughs, and certain other boroughs, the total number of authorities for this purpose being about 230.

Each of these authorities appoints a public analyst, the appointment being subject to the approval of the Ministry of Health who require to be satisfied of the competency of the person appointed in analytical chemistry, therapeutics, and microscopy. The public analyst is usually an analytical chemist in private practice and receives from the local authority a fee based on the number of samples examined. He may act as analyst for a number of authorities, and, in fact, the 230 appointments are at present held by about 100 analysts.

There is, however, a growing tendency, especially amongst the authorities of the larger areas, to establish laboratories of their own and to appoint whole-time analysts. In these cases the whole of the chemical and bacteriological work of the council is undertaken in the one laboratory.

The main statutory provision for prohibiting the adulteration of milk is contained in a section in the sale of food and drugs act

of 1875, which provides that no person shall sell to the prejudice of the purchaser any article of food which is not of the nature, substance, and quality of the article demanded by the purchaser. This at once raises the question, "What is milk?" This has been the subject of many decisions in the courts, and the effect of these decisions at present seems to be that milk is the fluid obtained by milking a cow, whether completely or not, with nothing added or abstracted. The fluid is none the less salable as milk if it is of inferior composition owing to bad feeding or other conditions.

There is thus no absolute standard of composition for milk; but the effect of certain regulations made by the Ministry of Agriculture and Fisheries is that, until the contrary is proved, milk is presumed to be adulterated if it contains less than 3 per cent of milk fat or less than 8.5 per cent of other milk solids. In the case of skimmed or separated milk, the presumption is raised if the nonfatty solids amount to less than 8.7 per cent.

It is obvious that milk of a composition above these limits may actually have been adulterated, but local authorities are generally unable to take any action in regard to such milk, and public analysts, in reporting on samples of milk, are required to have regard to the limits specified in the regulations.

The provisions of the sale of food and drugs acts are enforced by means of the purchase of samples by the inspectors of the local authorities. When the purchase has been made, the inspector informs the vendor that the sample has been purchased for analysis, and he divides the sample into three parts which he seals and labels. One part is sent to the public analyst for official analysis, and one part is handed back to the vendor in case he desires to have an independent analysis made. The third part is retained by the inspector; and in the event of proceedings being taken, the court, the local authority, or the defendant may require that it shall be sent to the Government chemist for analysis. The Government chemist is therefore practically in the position of having to decide appeals against the findings of public analysts.

A provision which gives rise to considerable difficulty in securing convictions for the adulteration of milk is what is known as the "warranty defense." A person who is prosecuted for selling adulterated milk must be acquitted, if he proves that he purchased the milk with a written warranty that it was genuine, that he had no reason to believe the contrary, and that he sold it in the same state as when he purchased it. As a person may be prosecuted for giving false warranty, it would appear that this is a reasonable provision for bringing punishment home to the party who is really guilty, but experience shows that while the provision commonly enables a vendor to escape conviction it is frequently very difficult to secure a conviction for giving a false warranty.

The milk and dairies (amendment) act, 1922, contains further provisions against adulteration. This act prohibits the addition of coloring matter, water, skimmed or separated milk, or reconstituted milk, to milk intended for sale, and also prohibits the sale of any milk to which such an addition has been made. Prior to the passing of this act, it was not an offense to sell a mixture of milk and water, or milk and separated milk, etc., provided that

there was no misdescription of the mixture; and consequently, there was a practice in some towns of selling these mixtures under such conditions that the purchasers believed they were buying milk, although in fact the article was not so described. Another effect of the new provisions is that it is an offense to sell any of the mixtures in question, even though the seller is not responsible for the adulteration, and the existence of a warranty is thus no defense. It is too early yet to say what the permanent effect of the new legislation may be, but it seems possible that it will prove effective in stopping up some of the gaps through which a dishonest dairyman was previously able to escape without any penalty.

In connection with the question of adulteration, reference must be made to the milk and cream regulations of the Ministry of Health. These regulations contain an absolute prohibition of the addition of any preservative substance to milk intended for sale. The same applies to cream containing less than 35 per cent of milk fat. Cream containing more than this percentage may only be preserved with boric acid or borax, or with hydrogen peroxide; and if it is so preserved it must be sold as preserved cream and must be labeled as "Not suitable for infants or invalids." The amount of boric-acid preservative must not exceed four-tenths of 1 per cent.

These regulations have been effective in stopping the use of preservatives in milk, but local authorities have had various experiences in dealing with cream. The statute under which the regulations are made only provide for a penalty for willfully refusing or neglecting to carry out the regulations, and some authorities have found it difficult to prove, for example, that the omission to affix a label to a jar of cream was willful. Other authorities have found it preferable to use the regulations as providing a sort of standard or guide for the interpretation of the sale of food and drugs acts, and have experienced no difficulty in obtaining convictions under those acts for selling as cream an article which is really cream and boric acid.

CLEANLINESS AND HYGIENIC CONDITIONS.

Until the last few years, the only administrative measures which have been taken to secure a cleanly milk supply, have been the imposition of certain requirements as to the conditions existing in dairies and cowsheds.

The predecessors of the Ministry of Health made three orders, known as the dairies, cow sheds and milk shops orders. These orders require local sanitary authorities to keep registers of all persons carrying on the trade of cow keeper, dairyman, or purveyor of milk in their district, but they do not enable an authority to remove a person from the register or to prevent him from carrying on the trade. This omission was partly corrected in the act of last year, which empowers an authority to refuse to register a retail purveyor of milk, or to remove such a person from their register, if they are satisfied that the public health is, or is likely to be, endangered by any act or default of his in relation to the quality, storage or distribution of milk. The retailer has a right of appeal to a court of summary jurisdiction and a further appeal lies to a

court of quarter sessions. Considerable use has been made of this new legislation to prohibit the sale of milk in small shops dealing in miscellaneous goods, and not properly equipped for the sale of milk; and in other cases no doubt it has already proved useful in securing an improvement of the conditions under which milk is sold.

Other provisions of the dairies, cow sheds, and milk shops orders require the proper lighting, ventilation, cleansing, drainage, and water supply of dairies and cow sheds, and prescribe precautions against the infection and contamination of milk. The general provisions of the orders are elaborated by regulations made by the local authorities themselves. These regulations, as a rule, are based on a model code prepared by the Ministry of Health, and are drawn up with the cooperation of the ministry.

In regard to disease, the orders do not go so far as is sometimes considered desirable. They do, however, prohibit the sale of milk from any cow which is suffering from cattle plague, pleuropneumonia, foot-and-mouth disease, or tubercular disease of the udder.

The orders have been supplemented by a provision in last year's act which imposes a heavy penalty on a person who sells the milk of a cow suffering from tuberculosis of the udder if he knew or could with ordinary care have ascertained that the cow was suffering from this disease.

It is one of the general principles of English local government that a local authority does not exercise any functions outside its own area, however much the inhabitants of the area may be affected by what goes on outside. In the matter of milk supply, this principle leads to the anomaly that where milk is brought from a country district into a town the town council have no authority over the conditions of production, whilst the authority of the producing area may have very little interest in carrying out a policy of strict enforcement of the orders relating to the production of milk—involving expense not only to the authority as such, but also to the inhabitants of the area they represent—if that area would derive little or no benefit from the expenditure.

There has accordingly been a certain amount of antagonism between urban and rural authorities in the matter of milk control and in the interests of the urban communities some inroads have been made into the principle referred to.

Thus the infectious disease (prevention) act, 1890, empowers a medical officer of health who has evidence that infectious disease may be caused by the consumption of milk to inspect the dairy from which the milk is supplied whether it is within the district of his authority or not. On his report, accompanied by that of a veterinary surgeon, the local authority may make an order stopping the supply of milk.

This act does not apply to tuberculosis, but the councils of about a hundred of the larger towns have obtained special powers from Parliament empowering them to take similar action with regard to milk likely to cause tuberculosis.

This system of legislation by local act involving the "invasion" of a district by the authority of another district has been adversely commented on by parliamentary committees and further powers on these lines have recently been refused. A general act which im-

posed on the larger authorities (the councils of counties and county boroughs) of the producing areas the duty of stopping the sale of tuberculous milk was passed in 1914, but the operation of this act was postponed on account of the war and has since been deferred until 1925.

MILK GRADING.

The encouragement of the production of clean milk by means of grading and certification is a recent development in this country. It was first adopted during the war when the food controller fixed maximum prices for a number of foods, including milk. A system was then instituted by which the food controller, on the recommendation of the local government board, issued licenses to persons who satisfied certain prescribed conditions, and those persons were entitled to sell their milk under special designations and at a price in excess of the ordinary maximum. The system of issuing licenses (but without reference to price) was continued after the cessation of the ordinary food control, and licenses for the use of special designations in connection with the sale of milk have been issued by the Ministry of Health under the powers of the war legislation.

This system was put on a permanent footing by the act of last year, and grading is now being established as a recognized part of the system of milk control in this country. The system is of a voluntary nature, and a person who wishes to sell his milk under a prescribed designation has to make application for a license, and pay a small fee which is intended to cover the cost of the bacteriological examination, etc., involved in the administration of the scheme.

Provision is made for five grades of milk (including subgrades) described as "certified," "grade A (tuberculin tested)," "grade A," "grade A (Pasteurized)," and "Pasteurized." The conditions which have to be satisfied by milk sold under these designations are laid down at length in an order made by the ministry. The general effect of these conditions (excluding some temporary relaxations) is as follows:

1. Certified milk must be produced from cows which have passed a prescribed tuberculin test and veterinary examination. The whole herd must be submitted to the test and examination at intervals of six months, and every animal added to the herd must be tested immediately before admission. The milk must be bottled on the farm and must not at any time contain more than 30,000 bacteria per cubic centimeter or any coliform bacillus in 0.1 cubic centimeter.

2. Grade A (tuberculin tested) milk is subject to the same conditions as certified milk as regards the testing and examination of cattle.

The milk must be bottled before distribution and must not at any time contain more than 200,000 bacteria per cubic centimeter, or any coliform bacillus in 0.1 cubic centimeter.

3. Grade A milk must satisfy the same conditions as grade A (tuberculin tested) milk, with the exception that the tuberculin test is not required, and that veterinary examinations of the cows in the herd are made at intervals of three months instead of six.

4. Grade A milk (Pasteurized) is grade A milk which has been Pasteurized by the holder process as defined in the order: that is to

say, it must be held at a temperature of 145° to 150° F. for at least half an hour and then cooled to 55° F., and it must not be heated more than once. It must not at any time contain more than 30,000 bacteria per cubic centimeter, or any coliform bacillus in 0.1 cubic centimeter.

5. Pasteurized milk is any milk which has been Pasteurized by the same process as is required for grade A (Pasteurized). The bacteriological condition for this grade of milk is that it must not contain more than 100,000 bacteria per cubic centimeter. There is no test for coliform bacillus, and the milk need not be sold in bottles.

For the present the Ministry of Health are themselves granting licenses to producers of certified and grade A (tuberculin tested) milk, but licenses to producers of grade A milk and to distributors of all grades of milk are granted by local authorities.

Chairman ROADHOUSE. It is of interest to learn of the control of milk in England and Wales as described by Doctor Hamill. Is there any discussion?

We have nine other papers on this morning's program, and if there are no questions, we will proceed to the next subject, "Present position of milk administration in Scotland," by Doctor G. Leighton, medical officer, and A. Stalker, Scottish Board of Health. Doctor Leighton. [Applause.]

Dr. G. LEIGHTON. After listening to the paper by Doctor Hamill about the English and Welsh administration of milk, I will not read my paper because it is simply a mere repetition of the conditions as cited by him. You can appreciably understand that the two countries lying so close to each other would have nearly the same conditions and laws existing in one as in the other. The milk crosses back and forth between the two countries, and for that reason when milk legislation is proposed it is the duty of Doctor Hamill and myself and others to meet together and consider what conditions will best suit us all. Therefore, my paper is almost an exact restatement of the facts as presented by Doctor Hamill.

In Scotland we are doing a great many things that are experimental. The grades that Doctor Hamill has described to you have been in existence, or in operation, for only a few months. They are purely experimental grades, and no one knows what the final legislative proposals will be. You have heard, for example, the counts that have been required, but no one in Scotland or in England can say just how those counts will work out a year hence. We have never done it before, and I would like to comment on the conditions that have been required; these grades and conditions are very likely to be altered as time goes on.

The important point brought out by the present position of law in England and Scotland is this: That up to one year or so ago we had no grading of milk at all; up to that time milk had been sold on a basis of flat rates whether it was good, bad, or indifferent, pure, impure, clean, or in any other condition. It was always so much water to the retailer and consumer, but that is no longer the case. We are trying to impress on the public that there is such a

thing as milk, milk, milk, and other milk. That is the real significance of the legislation.

Another thing I wish to bring out is this: That we in Scotland are profoundly dissatisfied with our present condition of legislation in regard to milk. Three years ago the departmental committee was appointed by the Secretary of Scotland to consider the whole question of legislation in the future. That committee, to which I was appointed along with representatives of the dealer, the retailer, and others, issued a report in the manner of recommendations. They recommended the standards of milk as described by Doctor Hamill; that is, the standard that if milk falls below a certain mark it is presumed to be adulterated and the person has to be proven innocent. They also recommended:

That there should be regular and frequent samples of the milk; that milk recording should be encouraged. That a first offense against the standard should in all cases be the subject of a warning; that certain means should be adopted to insure that the responsibility for defective samples were placed on the proper individual; and that after four convictions in court it should be within the power of the local authority to withdraw the certificate of registration from that milk vendor.

Those are the most important recommendations of that committee and we, in Scotland, hope that before long we will be able to have them embodied in the law of the land. [Applause.]

(Doctor Leighton's paper is given with those read by title below.)

DR. STENHOUSE WILLIAMS (Reading, England). I want to point out that both Doctor Hamill and Doctor Leighton have spoken on this subject from the side of the public. I think I might be permitted to speak to you from the agricultural side of the question—that is, from the standpoint of the dairy farmer, with whom I work—and I would like to say that so far as my knowledge goes, I think there are one or two points to be considered.

First, that it is entirely optional as to the class of milk you will produce, whether it is tuberculin tested or class A. If you do produce these you must have a license and show you are doing your business. I think myself that the fact that this has been optional—in that it left it to the farmer himself to decide what he will do, and the dealer, also—has been one of the greatest things done. In our experience we find that the people who are coming in are not being forced in, and effort is being made by those coming in to carry out the licenses as is required of them. They are getting a price which leaves them a profit. We, in England, are also finding an interesting fact that the farmer is taking an interest in the tuberculin tests. The farmer is doing this and is finding it a paying proposition.

Another thing is noticeable: In carrying out this work in their cow sheds, they are improving the quality of their labor right through, and extra intelligence is being developed in other subjects. I do not know a single grade-A farmer in England who has a desire to go back, and a great many of them are coming in.

Chairman ROADHOUSE. Is there any further discussion?

If not, we will pass on to the next subject. "The extent to which bacteriology can be used administratively to improve the milk supply," by Dr. W. G. Savage, county medical officer, England.

Doctor HAMILL. Doctor Savage is unable to be present, but asked me, with your permission, to read his paper for him. I will say that I do not necessarily identify myself with any of the views presented therein.

(Doctor Hamill read the prepared paper of Dr. W. G. Savage.)

THE EXTENT TO WHICH BACTERIOLOGY CAN BE USED ADMINISTRATIVELY TO IMPROVE THE MILK SUPPLY.

WILLIAM G. SAVAGE, M. D., county medical officer of health, Somerset, England.

We are all agreed that special supervision over the production, transmission, and distribution of milk is necessary. Experts are equally agreed that conditions, as they exist in England, are far from satisfactory and that material improvements are necessary. The present paper is concerned with a discussion as to the extent to which bacteriology can be used for this purpose.

In the first place, two different problems are involved. One is the detection of pathogenic bacteria; the other, means to improve the cleanliness and general quality of the milk supply.

DETECTION OF PATHOGENIC BACTERIA.

As regards the most important bacillus, the tubercle bacillus, nothing can replace bacteriological methods. The tuberculin test, in its various forms, is a bacteriological method, and is the only reliable method for detecting tuberculosis in cows, and eliminating the disease from the herd.

Apart from that, I am of the opinion that efficient bacteriological examination of the milk (using inoculation procedures) is much more reliable as a means of telling whether the milk supply is infected with tubercle bacilli, than a detailed veterinary physical examination of the herd. The detection of tuberculosis in inoculated guinea-pigs is definite evidence of the presence of pathogenic viable tubercle bacilli in the milk. It does not throw any light upon which animals are at fault and is only preliminary to, and has to be supplemented by, a detailed veterinary examination of the animals. It is, however, a nearly essential preliminary.

As regards the detection of other pathogenic bacilli, the difficulties are so considerable that the utility of bacteriology as an administrative measure is very limited. It is, however, valuable in certain cases, mastitis in cows, etc.

IMPROVEMENT OF GENERAL QUALITY OF MILK SUPPLY.

It is mainly in the second category—i. e., to improve the general bacterial quality of the milk supply,—that discussion is most important, and the rest of this paper will be confined to this aspect of the subject.

There are four lines along which attempts to improve the milk supply have advanced. These are:

Universal Pasteurization.

Grading of milk.

Establishment of fixed bacterial standards of purity, failure to comply with which is a punishable offense.

Supervision of the supply with powers of enforcement and fine for breach of regulations.

Universal Pasteurization alone, without supervision, stands self-condemned. It is a confession of failure which submits to the view that milk must always be dangerously contaminated, and that safety lies only in destroying, by heat, bacteria, the entrance of which can not be prevented. As an adjunct to other methods, a great deal may be said for it, but alone, without supervision, it should have no friends. Bacteriology is useful and indeed essential to estimate the efficiency of pasteurization. If milk is efficiently Pasteurized—i. e., so as to remove all danger from harmful bacilli—the organisms should be reduced below a definite number. In the Ministry of Health regulations these are: "The milk at any time after Pasteurization, and before delivery to the consumer, must not contain *Bacillus coli* in 0.1 cubic centimeter and must not contain more than 30,000 bacteria per cubic centimeter.

Grading of milk is again a valuable adjunct to improve the milk supply, but inadmissible as a final aim, since it would then condemn us to the proposition that dirty milk, like the poor, will always be with us, and adds the rider that the latter must always drink the former. The grading of milk must be done on bacteriological standards, but as this is recognized they do not require detailed discussion.

Fixed bacteriological standards for milk, noncompliance with which is a punishable offense, have been studied and put into operation in United States of America. The case for such standards can be put with considerable cogency. Dirty milk means bacteria-laden milk. The potential harmfulness of such a milk is in direct proportion to the number of bacteria in it, since while the number of harmful bacteria can not be determined in each sample, yet in general there is a close proportion between the total number of organisms and the number of pathogenic bacilli. It is experimentally demonstrable that care and cleanliness in milking, and subsequent care of the milk, are at once reflected in a proportionate diminution in the total number of bacteria. Theoretically, these arguments are very strong, yet administratively I have never been in favor of fixed bacteriological standards, an opinion shared by most experts in this country.

While other minor objections may be raised to the use of a fixed bacteriological standard, the two most important defects in my opinion are the following: It is too sensitive an instrument, administratively, for fixed legal standards. For one thing, the so-called total number of organisms is not a definite figure: it is not in any sense the total number but merely the number which will grow under certain rigidly defined conditions of media, temperature, etc. While much can be done by the standardization of procedure to remove these objections, they do offer difficulties in the way of legal standards.

The other objection is that a fixed bacteriological standard is likely to be ineffective to detect and penalize the worst offenders. It will be emphasized later how vitally the number of bacteria in vended milk is influenced by the time and temperature conditions following milking. A fixed regulation magnifies disproportion-

ately the influence of time and temperature. A man who produces milk under dirty conditions, involving gross initial contamination, may escape trouble because he cools well, or is fortunate in the fact that he lives near the city so that his time interval is short. Maximum conditions of time and temperature have to be allowed for, which means a lenient standard. This vital relationship is discussed below, and it is a strong argument against fixed legal standards, unless they are complicated by differing standards for different conditions; that is, for byre and vended milk separately.

Bacteriology finds its greatest utility when used in conjunction with general methods of supervision over the milk supply. There are only two procedures by which to decide if the conditions under which milk is produced and kept are satisfactory. One is to study on the spot the methods practiced; that is, to inspect. The other is to judge by results, bacteriologically.

The system of trying to improve the milk supply by supervision by a sanitary staff is the one employed in England, but with results which are the opposite of successful. The fault of that would seem to be intentional, or at least it would appear so to the impartial outsider, since the powers of control are deliberately placed, and maintained in our latest act (1922), in the hands of bodies (the rural district councils) the majority of the component members of which are themselves either milk producers or interested directly or indirectly in the industry. This has always stultified measures of reform and retarded progress. Apart, however, from this crushing handicap, serious inherent defects are noticeable.

The ordinary sanitary inspectors who do the detailed inspections are, as a class, not experienced in this work in the sense that they are not well grounded as to which are the factors of importance in procuring clean milk. They are apt to fasten on minor defects of equipment and to pay very inadequate attention to the importance of proper methods in milking. Even when experienced, their opportunities are limited. An inspector usually can devote but a fraction of his time to milk-inspection work. It is common for one inspector to have anything from 300 to 500 cow sheds in his area. It is quite impracticable for him to be present at actual milking times except in a minority of cases, while it is obvious that he can not be expected personally to supervise milking operations at 6 or 7 in the morning. He can not have anything approaching a proper appreciation of the way actual milking operations are conducted, of the care and cleanliness of milk vessels, of the procedures of transmission, or of the care given to the milk in the hands of the milk purveyors.

It is to supplement these deficiencies and act as a complement to inspection methods, that bacteriology could be made so useful. It finds its greatest utility as a sorting agent, to pick out, as it can with tolerable certainty and uniformity, the milk producers and others whose methods of handling milk are below a reasonable standard. What we need is an elimination of the really dirty milk producers, a weeding out of the worst, who must either mend their ways or go out of a business such as milk production for which their ideas unfit them. In this way a steady levelling up of the whole milk trade can be achieved. To attain such objects bacteriological examinations

must be used in the right way. In the past, they have been utilized mainly to examine milk as vended, chance samples being collected about which nothing is known, either as to the conditions at the farm, the temperature at which kept, or even the time since milking. Figures so obtained are not very helpful at any time and are often valueless.

The cardinal defect of almost all bacteriological tests which have been advocated are that they are based upon enumerations which are affected by time. The bacteria multiply in the milk so that the numbers present in the vended sample can not be used as any guide to the numbers present at any stage of production unless the exact time and temperature conditions are known.

In 1909-10 I extensively studied this problem, the results of which are set out in a report to the local government board (Report of the Medical Officer 1909-10, Appendix B, No. 4. Report upon the bacterial measurement of milk pollution). They led me to the view that to be of service we must have separate working standards for byre (i. e., cow shed) samples, and for vended samples, and that the latter would have to be varied for summer and winter. It was shown, for example, that if ordinary freshly milked samples were kept at 15° C. for 24 hours—i. e., maximum temperatures and time—the increase in *B. coli* was usually one hundredfold, occasionally a thousandfold, and practically never greater than this. If we accept the standpoint that bacteriological examinations are to enable us to judge conditions at different stages, and not as absolute standards, it is quite obvious that such different working standards are essential.

Before considering how such bacteriological measures are to be worked, what bacteriological tests to use demands consideration. Nearly universally the standard adopted is one of the number of bacteria per cubic centimeter. It has conspicuous limitations. As already explained, it is meaningless unless defined. It never is the total number of bacteria present; merely an arbitrary figure based on the number of organisms which will develop under defined conditions in a medium of minutely prescribed composition. For samples collected at the cow shed, the numbers found do reflect closely the cleanliness precautions adopted; but when we come to the vended samples, the flora is so varied that very wide variations are met with as to the rate of multiplication, and the influence of different temperatures, so that very variable results are obtained. When samples collected at the cow sheds were held at 15° C. for 24 hours, the rates of increase were most variable, and far less regular than when a *B. coli* standard was used. The enumeration is subject to considerable irregularities, due to technical differences and minute differences of composition of media. It is recognized that considerable variations in results may occur, when apparently the same technique is used by different workers. The ingenuity of various American workers (particularly the direct counting method of Breed) has given alternative methods but has not removed the difficulties.

The report of 1909-10 advocated the use of *B. coli* as a more satisfactory test, and with further experience I am still of the same opinion. Using the term here to connote lactose fermenters of coli type, the test is easily carried out and is not liable to technical variations, but all workers can get the same results. It has also two conspic-

uous advantages. One is that, being only a small group of organisms, they multiply more uniformly in milk, with time and temperature variations, so that it is possible to establish standards for vended milk which bear some relationship to initial conditions. In other words, we can postulate a permissible initial contamination, e. g., one *B. coli* per cubic centimeter and ascertain that under maximum conditions of time (24 hours) and temperature, the number of these organisms will not be more than a given figure, and frame our limits for vended samples accordingly. This I did in the report mentioned.

The other advantage is that this estimation gives a closer guide to the faulty conditions we wish to eliminate than a total bacterial count. Clean milking in its essentials means keeping out materials rich in the *B. coli* group; it is therefore a more direct index of contamination.

In practical use the ordinary decimal methods of enumeration are unsatisfactory as the spacing is too wide, and a procedure on the lines advocated in my book, "Milk and the Public Health," 1912, should be used.

For quick sorting out purposes the following dilutions are convenient. They are added to tubes of lactose bile salt broth and the results (positive=acid and gas) are read off at once after two days' incubation at 37° C. With this medium, plating out and identification of the organism are not necessary:

Byre milk:

1 cubic centimeter of milk inoculate 2 tubes.

0.1 cubic centimeter of milk inoculate 2 tubes.

Vended milk:

0.1 cubic centimeter of milk inoculate 1 tube.

0.01 cubic centimeter of milk inoculate 2 tubes.

0.001 cubic centimeter of milk-inoculate 2 tubes.

0.0001 cubic centimeter of milk inoculate 2 tubes.

Sorting standards such as the following may be used:

Lactose fermenters of coli type per cubic centimeter.

Source of sample:

Byre (i. e., at cowshed)—

Winter (October to April, inclusive); Summer (May to September, inclusive.)

Below reasonable standard if either or both 0.1 cubic centimeter tubes positive.

Vended—

Winter—Unsatisfactory if both of the 0.01 and the 0.1 tubes are positive, and decidedly so if lower dilutions positive.

Summer—Pass if only the 0.1 and 0.01 tubes positive; condemn if either or both 0.001 positive; between rather unsatisfactory.

Of course these sorting standards apply only when no Pasteurization or other form of heat has been applied.

I am glad to say that the use of the *B. coli* test on the lines recommended by me has been adopted by the Ministry of Health in connection with their graded milk requirements and standards.

When only these few tubes are used, the laboratory work is greatly reduced and very many samples can be examined with speed.

In actual working, the use of bacteriological sorting methods is greatly facilitated by the present fashion of collecting milk at depots, to which the milk is brought and from which it is transmitted, to the big centers of population. The milk arrives at these depots within very restricted times and it is easy for the milk inspector to sample 20 or 30 milk supplies in an hour or so, collecting a few ounces from each in sterile bottles. These could be transmitted at once to the nearest laboratory, and all the samples promptly and rapidly put in hand. The results have only to be read off. In this way the inspector could pick out all the producers shipping really dirty milk, and would know which ones to visit and inquire as to their methods of production. There are some 45 such depots in the county of Somerset, England, and they each deal with from 1,000 to 8,000 gallons of milk a day, according to their size. While there are no legal powers of sampling in this way, the depot owners, who are always complaining of the dirty quality of the milk supplied to them, would be only too glad to facilitate the examination.

It is along these lines that I consider bacteriology could be utilized to act as the sorting agent for inspection work, and as a potent means to pick out the worst offenders at the farms, where in my experience the greatest contamination takes place, and where the greatest need of improvement is manifest. The cost is trivial compared to the cost of inspection methods. One extra laboratory officer could carry out a vast number of examinations in the year.

Chairman ROADHOUSE. Is there any discussion on this paper read by Doctor Hamill?

Mr. GEO. F. GOSNEY (National Association of Creamery Proprietors and Wholesale Dairymen, London, England). It so happens that I am quite well acquainted with both Doctor Hamill and Doctor Savage, and I am perfectly in agreement with them that the first line is with the farmer. I am afraid that our friends from the other countries will think we are most benighted, and I am ashamed to say that their opinion will be correct if they do think it. But the result of our visit to America will send us back to the old country with new ideas and new experiences. I want to say that we have many difficulties that you do not have over here, and the first is the unenlightened public opinion. Until the last few years it did not make any difference to the public what the milk was or what it contained.

I do think that the practical result of our visit over here is that we shall go back to the old country and preach, first of all, the need for milk, and the need for good milk, and that the producers, distributors, and dealers, who are here, will go back and work together with one another more than ever before. I think what we should do is go back and raise the standards so that the poorer classes will be able to have as good milk as those who can afford to buy the best grades at the present time. We should preach the use of milk, and more milk as a food. If we do that, I believe we will do a very great deal for the health of our nation. [Applause.]

Chairman ROADHOUSE. Is there any further discussion? If not, we will proceed to the next subject, "The supply of milk to large towns," by Dr. S. Orla-Jensen, of Copenhagen, Denmark. [Applause.]

THE SUPPLY OF MILK TO LARGE TOWNS.

SIGURD ORLA-JENSEN, Ph. D., D. Sc., professor of technical biochemistry, Royal Technical College, Copenhagen, and president, Danish Section of the International Dairy Association.

Although we in Europe have much to learn from America concerning the supply of milk in towns, I nevertheless think that Americans might be interested to hear a little of the means which we, who are working with these problems in the Scandinavian countries, have thought of employing in order to improve the quality of town milk, without, however, increasing the price to any notable extent; for it must be remembered that now in Europe after the war there are but few people who can pay whatever price may be asked, even for good milk.

Regarding the fat content of the milk, I will only observe that the demand that whole milk shall be sold with exactly the same fat content as it has straight from the cow, such as is still embodied in most European milk regulations, is quite absurd. All that should be required is the guaranty of a certain minimum of fat content. The reason for this is that milk distributors can not be satisfied with paying for the milk which they buy, according to fat percentage, if they are prevented from utilizing any eventual excess of fat. As long as this is forbidden, the interests of the dealers will be in the direction of buying poor milk, which contains no more than the minimum amount of fat, and thus they will not be inclined to encourage the farmers to improve their herds with cows giving particularly rich milk.

In this connection I wish to draw attention to the Høyberg method for the determination of fat in milk and cream. With the latest improvements, this Danish method is not only as exact as the best of the other quick methods, but it is so much simpler, that, I am sure, it will soon supersede the other methods. To some extent it is like the Gerber method; but for the separation of the fat, the corroding sulphuric acid and the centrifuge used by both Gerber and Babcock are avoided, and as the fat is separated only in a simple water bath, the Høyberg test can be made on any table or desk.

As regards the other qualities of town milk, it should be demanded that the milk be free from pathogenic bacteria without first having to be boiled; that it keep, provided that it is not exposed to undue heat, from one morning to the next. It is not only a cause of inconvenience to the customer when a part of the milk which has been bought is spoiled, but, of course, the cost of that portion of it which has been usable is increased quite considerably.

In the different countries, the question of meat and milk control were taken in hand by the veterinary surgeons in particular, and the chief emphasis was therefore laid on the conditions affecting the state of health of the milk-producing cows. Many excellent

directions have been worked out for producers of town milk, the carrying out of which can be controlled from time to time at the place of production by veterinary surgeons appointed for the purpose. It is only recently that an interest has been awakened by milk experts proper, in the production of palatable milk of good keeping quality; and quite rightly, more emphasis has been laid on the selling of the milk in good condition than on the following of certain rules in its production.

In order to produce milk which will keep, cooling is by far the most important condition. The milk should not only be cooled immediately as it comes from the cow, but it should be kept cool during transport to the town; it should further be cooled at the distributing depots and also be kept cool during distribution and in the shops. Peculiarly enough, nothing is to be found regarding this point in the present European sanitary regulations. I have been gladly surprised to see how advanced America is in this direction.

By means of the fermenting and reductase test which I have worked out, it is possible to ascertain very easily whether the milk has been well cooled and cleanly handled. The basis for this test is the observation of several German investigators and especially of the Swedish investigator, Barthel, that milk, colored with a little methylene blue, will be decolorized more quickly the more bacteria it contains. Originally the test was carried out at 45° C. to 50° C. I have in the meantime showed that the most favorable temperature for the reductase test is, as a rule, at 38° C.—i. e., just the temperature at which the fermenting test of the cheese factories should be made—in this way a combination of the two tests became possible.

While the reductase test gives a measure of the number of bacteria in the milk, and of their vitality, so the fermenting test affords an indication as to whether good lactic-acid bacteria, or harmful gas-producing or peptonizing bacteria predominate in the milk. The reductase test shows whether the milk has been properly cooled, and whether it will keep, while the fermenting test shows whether the milk has been more or less contaminated, especially with the coli and butyric-acid bacteria which occur plentifully in dung. From the combined reductase and fermenting test one thus gains a valuable insight into the bacterial condition of the milk, an insight much more complete than that attainable by the costly and troublesome plate counts, a method which would, of course, be absolutely unmanageable in the control of milk which daily pours into a large town. The direct counting under the microscope after the Breed method is, for so many samples, too tiring, demands great experience, and one can not see whether the bacteria are living or not.

The fermenting and reductase test, however, affords no indication as to whether there may be harmful substances or specific pathogenic bacteria in the milk, and it can therefore never render superfluous medical and veterinary control at the places of production. It must, on the other hand, not be forgotten that the fermenting test is an excellent indicator as to whether the milk has been contaminated with harmful colon bacteria; and that the reductase test is an indicator of bacteria, especially as to whether harmful bacteria have had the opportunity to develop in the milk. The fermenting and reductase test is, therefore, not only a measure of the palatability

and keeping power of the milk, but it is also an important indicator from a hygienic point of view.

With the help of this test, milk can be divided into four classes,¹ which form an excellent basis for payment by quality, and in this way the producers will become interested in making efforts to supply good milk, whereas of course they only regard all municipal regulations with hostility. Payment according to quality on this basis has now been introduced into 80 per cent of the dairies in Finland, into many Swedish dairies, including the most excellent milk supply of Stockholm. During recent years this system of payment has also become very prevalent in Danish dairies, though it is not yet used in the milk supply of Copenhagen.

In Finland, the result of the system of payment by quality has been the total disappearance of class 3 and class 4 milk, which are penalized by price reductions, and the same would no doubt happen in other places.

There will thus only remain the two best qualities: Class 1, which can be sold for drinking and which should therefore be sold in bottles; and a class 2 milk which can be used for cooking purposes and which, for the sake of cheapness, should be sold from cans. As milk for cooking purposes will at all events be heated, it is only natural to sell it in the Pasteurized state, which will increase its keeping power, and will prevent any harm, even if it is used for drinking purposes. Neither will it be possible to avoid the Pasteurization of class 1 milk, if there is to be any guaranty that this can be drunk without any danger; for even the best medical and veterinary control at the places of production can never be anything but a net with very wide meshes. It has happened that of a so-called tubercle-free herd supplying milk to Copenhagen, 80 per cent of the cows reacted on a second examination; and in Copenhagen we had a scarlet-fever epidemic caused by nursery milk which had been specially well controlled.

Even if we could now avoid such serious cases by further sharpening the control at the places of production, we shall never succeed in excluding from consumption milk from cows suffering from lighter digestive disorders, and such milk, which of course must unavoidably be infected with cow-dung, is capable of causing similar disorders in children who drink it raw. It would also mean quite a ridiculous loss to the producer to forbid him to sell such milk, which is excellent if only it is Pasteurized. If, however, drinking milk is to be Pasteurized, it is only reasonable to Pasteurize it in such a way that it is altered as little as possible in chemical characteristics, and this object is best achieved by the so-called holding Pasteurization, heating to 63° C. for half an hour.

By this method of Pasteurizing, which I recommended as early as 1905,² and which now is used in nearly all countries, especially here in America, where it is the generally used method, the common pathogenic bacteria are killed, and the keeping quality of the milk is enhanced, with the same certainty as in heating to 80° C. to 90° C. momentarily. The proteins of the milk and its antitoxins, however, are not altered, and as regards vitamins, the most that could happen would be some injury to the vitamin C, and this, of course, can be

¹ Orla-Jensen, S. Dairy Bacteriology. 1921.

² Landwirtschaftliches Jahrbuch der Schweiz, 1905. Orla-Jensen, S. Dairy Bacteriology, pp. 81-86 und 97. 1921.

made good by a little orange or lemon juice, as is so well known here in America. Milk Pasteurized by the holding method also offers the advantage, as has been pointed out by Ayeis and Johnson, that the good lactic acid bacteria in it are not completely killed, for which reason it becomes sour only on long standing, and not putrid like flash Pasteurized milk.

As we have not yet any certain reaction to determine whether milk has been Pasteurized at a low temperature, it necessarily follows that such milk must be sold only by large well-organized firms, which can be inspected and which will constantly be controlled by their staffs. The same holds good also as regards control in the classifying of milk and its treatment. On the other hand, in many small businesses in which the milk is handled only by the members of the family, all control fails. Treatment of town milk should therefore be exclusively in the hands of large, well-organized concerns which have at their disposal the necessary technical knowledge and machinery. An arrangement like this need by no means affect the existing small concerns detrimentally, for they could simply combine to erect a cooperative dairy for the treatment of their milk.

According to what has been said here, the following three conditions are necessary for the production of really good drinking milk—i. e., milk which is palatable and which can be given to children without having first to boil it:

1. Veterinary control of the cows and medical control of the staff which has the handling of the milk by which the majority of the most dangerous pathogenic germs and toxins are excluded.

2. Payment according to quality of the milk, based not only on the fat content but also on the fermenting and reductase test, leading to a palatable product of good keeping powers in which one can be sure that there are relatively few fecal bacteria, and which has been treated in such a way that the pathogenic bacteria which will unavoidably be found even in the best milk have not been able to increase.

3. Low-temperature Pasteurization by which the keeping powers of the milk are further enhanced without the milk being appreciably affected chemically and by which such harmful bacteria as may be present in it, in spite of the two foregoing conditions, are killed.

In Denmark only the first of these three conditions has hitherto been fulfilled, which is all the more remarkable, as this is the only one which involves expense and therefore increases the price of town milk. The system of payment by quality could, to begin with at any rate, be arranged so as to be self-supporting—i. e., that which is deducted in payment for bad milk is applied as a premium for the best milk. If eventually it should really come to pass that town milk consisted of only class 1 milk, then this would of course involve a slight increase in price, based on a real improvement in quality, by which all parties would benefit. Moreover, there would always be the option of increasing the standard further in such a way that what is now called class 1 milk would be divided into various grades of fineness, and customers desiring cheaper milk for cooking might be recommended to use dried milk. Finally, as regards low-temperature Pasteurization, this does not involve any increase in the price of milk, as experience has shown that the milk is improved so much in keeping power that the expense of the holding Pasteurizing process itself is more than regained in the saving of cooling material.

It follows as a matter of course that the date of Pasteurizing should be printed on the label for drinking milk, and that this milk should be kept in well-cooled ice chests in the shops, so that customers can be sure that it is really good when bought.

Regarding milk which is used for infants, the so-called nursery milk, the Danish regulations provide that it should come from tubercle-free herds; and that it may be sold in the raw state only. This latter condition, of course, decreases its keeping-power quality, but is necessary as long as medical men insist that the mixture of milk given to children be boiled at home. If, however, one had drinking milk of the high quality described above, it would be easiest and best to use this for infants, for it could be made lukewarm simply by adding to it boiled sugarwater in the right proportion, without having to heat it specially. It is especially undesirable to boil milk for infants; it should only be Pasteurized at a low temperature and of course only once. If one wishes to carry out this process oneself, it may be done by means of the household Pasteurizing apparatus which I have devised.

If there is any danger in drinking raw milk, the danger in consuming the raw cream is far greater, as the tubercle bacteria tend to pass into the cream. One often sees a mother anxiously preventing her children from drinking raw milk and yet giving them ice cream or cakes with whipped cream. The sale of raw cream should therefore be forbidden under all circumstances.

Hitherto we have been concerned only with the supply of good milk to towns; it is also of interest to supply them with cheap milk, and here difficulties arise when the towns grow so large that they require the entire production of the territory within the limits of safe transportation. If large areas of the country have to be utilized for the supply of milk for a town, the keeping-quality of the milk at the places of production must be increased. The most rational procedure is to make milk powder so as to reduce the costs of distribution to such a degree that this product, in spite of the expenses of evaporation, can be sold more cheaply than fresh milk in the large towns. Dried milk can be recommended especially for cooking purposes, among other reasons because one can always have a stock of it in the household. As whole milk powder generally acquires an unpleasant taste when it becomes more than three or four months old, it should preferably be sold in packages with the date of production stamped on them.

Great interest attaches to a new Danish method of sterilization, that of Jonas Nielsen, which renders it possible to supply towns with good milk even from remote districts and in warm countries. This is a method of continuous sterilization, in which the milk is kept under pressure in a closed system of tubes for only a fraction of a minute at 130° to 135° C., whereupon it is immediately cooled thoroughly in a similar closed system of tubes. By an ingenious arrangement this milk is now drawn off into sterile cans in such a way that the outer air can not come to it, and in this way a product of indefinite keeping quality is obtained, which curiously enough is not more changed in chemical properties than milk Pasteurized by the ordinary flash process.

Chairman ROADHOUSE. Is there any discussion of this paper? If not, we will pass on to the next paper, "The hygienic and economic control of market milk production in New York State," by Professor Breed, of the New York Experiment Station at Geneva. [Applause.]

THE HYGIENIC AND ECONOMIC CONTROL OF MARKET MILK PRODUCTION IN NEW YORK STATE.

ROBERT S. BREED, PH. D., chief in research, New York Agricultural Experiment Station, Geneva, N. Y.

New York, the Empire State, with more than 10,000,000 inhabitants, of which about one-half live in cities of large size, is at the same time one of the leading dairy States in the Union. Because of favorable agricultural conditions and the large milk-consuming population in the cities, this State unquestionably produces larger quantities of milk for consumption in fluid form than any other State.

Under these conditions, it is natural that problems in the sanitary and economic control of market milk have been studied extensively in the State, and that some of the ideas that have been found most useful in solving these problems have either originated, or have found extensive use, in connection with the control of the milk supply of the cities of the State. Thus it was in New York State that some of the earliest forms of dairy score cards were developed and used. The so-called Cornell dairy score card, developed by Dr. R. A. Pearson, at Ithaca, in 1905, was one of the earliest of these cards put into effective use in milk-control work. This was used on the milk supply of Ithaca, N. Y., in 1906, and on that of Geneva, N. Y., by Dr. H. A. Harding, in 1907-1911.¹

Practically simultaneously, the men responsible for the milk inspection work for New York City (Dr. H. M. Biggs, Dr. W. H. Park, and others) developed a dairy score card suitable for use in the control of the dairies sending milk into the metropolis. Other cities of the State followed these examples, and in 1913 the State department of health, under Dr. H. M. Biggs, made it mandatory to use a modification of the so-called official dairy score card² in all of the cities of the State other than New York City. The official card used in this case had been developed by a committee of the Official Dairy Instructors Association, a national organization of agricultural college and experiment station workers, which is known at the present time as the American Dairy Science Association.

While the thought in mind of the originators of these cards, as expressed by Doctor Pearson, was that the scoring of dairies on a percentage basis could be made an educational force for the improvement of farm conditions, in much the same way as the score card for beef cattle had been and still is used at agricultural expositions as an educational agency for the improvement of this type of cattle, the dairy score cards quickly came to have a far less satisfactory use.

¹ New York Agr. Exp. Sta. Bull. 337, 1911; and Bull. 353, 1912.

² Copies of all three of the dairy score cards mentioned in this paper will be found in Bull. 398, 1915, N. Y. Agr. Exp. Sta.

Almost immediately the numerical expression used as a score was seized upon as a convenient index of the quality of the milk produced in the dairies scored, and dairies were excluded from selling their milk on the basis of the dairy score alone, without regard to the quality of the milk produced. The numerical index or score also found extensive use in the systems for grading milk developed at the same time.

So firmly did the idea become established that there was a close relation between the dairy score and the quality of the milk produced, that it was a shock to many persons interested in milk control work when the obvious fact was pointed out in various publications³ that high-class clean milk was frequently produced on farms with a very low dairy score, and that likewise many farms with fine equipment and apparently good methods nevertheless failed to produce high-class milk. Thus the use of the score as an index of milk quality was found to be a highly unsatisfactory instrument from the consumer's as well as from the producer's standpoint. Likewise the frequent stressing of unessential things in these score cards caused unnecessary expense to the producer, thereby increasing the cost of production of milk. This caused either an unfortunate loss to the poorly paid dairyman or it was reflected in the increased price paid by the consumer.

An extreme contrast in the cost of high-class milk is brought strongly to the attention of the traveler to-day in the voyage from New York to Naples. In New York certified milk, produced with the extreme of refinement and complexity in equipment and methods, sells at 25 to 30 cents per quart. In Naples, where the very primitive system exists of driving the goat or the cow to the consumer's door, clean milk of high grade sells for about five cents per quart. One wonders which is the more desirable: A high-grade milk produced under primitive conditions at a sufficiently low cost to be used by everyone; or a high-grade milk produced under such complex conditions that its cost is prohibitive to all except the wealthier classes.

Some may object to this comparison on the ground that it is not an entirely fair one, and the objection is readily granted. Nevertheless, there is enough truth in it to be worth serious consideration. The cost of milk to the American consumer during the war period rose to such a point that many control officials came face to face with the problem of keeping the cost of production low enough so that the poorer classes could purchase a sufficient quantity of this essential food for the use of their children. Even though these conditions are not as acute as they were, the evil that foolish and unessential regulation can do is still with us.

Coincident with this use and misuse of dairy score cards in New York State, there has also been a development of simple and useful methods of so analyzing milk as to determine both its food value and sanitary quality. Even before dairy score cards had been suggested, Dr. S. M. Babcock had developed his simple method for determining the fat content of milk, a method which to this day remains as a most practical and fairly adequate measure of the food

³ New York Agr. Exp. Sta. Bull. 398, 1915.

C. E. North. *Farmers' Clean Milk Book*. John Wiley & Sons. 1918.

value of milk. While the State of New York must grant to our generous rival in dairy matters, the State of Wisconsin, the major portion of Doctor Babcock's life work, yet it should not be forgotten that he did his pioneer work with his fat test in the old administration building at Geneva, and that the New York Agricultural Experiment Station, through the work of Dr. L. L. Van Slyke, with the Babcock fat test, contributed many of the facts which are now matters of common knowledge.

At the time when Doctor Babcock was doing his pioneer work at Geneva (1886), the adulteration of city milk supplies, by skimming or watering, was altogether too common. The State entrusted the work of enforcing the laws enacted to control this situation to a newly created State dairy commission. This has now grown into the State department of farms and markets and has, with the cooperation of various local agencies, reduced the adulteration of milk to a negligible factor.

Among the pioneer cities of the State to make use of bacteriological counts as a laboratory routine in the control of the sanitary quality of the milk supply were New York, with Dr. W. H. Park in charge; Ithaca, with Prof. W. A. Stocking in charge; and Rochester, with Dr. G. W. Goler in charge. The development of this type of control has been badly handicapped because of the cost of establishing laboratories and the difficulty in securing an adequately trained personnel to do the work. For these reasons, New York State workers in this field have felt keenly the need of so simplifying routine analytical procedures that much larger numbers of samples could be handled at a small cost. Thus the New York City laboratory was one of the early advocates of beef extract in place of beef infusion agar, and later urged still further simplification of the ingredients of the agar in order to save unnecessary expense. Dr. C. E. North has advocated the simplification of the plating procedure with the use of fewer plates, and Dr. M. C. Schroeder adopted the sediment test suggested by various European and American workers and made it suitable for the examination of large numbers of samples of milk taken as it was delivered at the receiving stations. The author of the present paper has advocated the microscopic examination of milk as a still simpler method of determining the bacterial quality of milk than the agar plate method. All of these changes or procedures have found their use in the State and have been incorporated from time to time in the Standard Methods for Milk Analysis issued by the laboratory section of the American Public Health Association. The experience gained from the use of these simplified routine methods has emphasized the necessity of examining a series of samples from a given milk supply before rendering judgment regarding its sanitary quality.

With the increasing use of these analytical methods, there has been an increasing realization on the part of milk dealers that good business methods demand that they likewise maintain laboratories of their own whose function it is to make sure that the products which they offer for sale shall meet the standards fixed by regulation. Such laboratories are now maintained by all of the larger milk companies in the State, and they function so well that the burden placed on the municipal control laboratories is materially

lessened. Such laboratories are not feasible for small dealers, nor are adequate control laboratories feasible for small cities. Conditions under these circumstances are usually still unsatisfactory, unless some combination of effort has provided adequately equipped laboratories with a trained personnel.

New York City was the pioneer in the grading of milk into the classes commonly known to-day as grades A, B, and C, raw or pasteurized, milk. This grading system originally introduced by the city became mandatory in the entire State in 1913.⁴

At first six grades of milk were recognized, three of raw and three of Pasteurized milk. These were to consist of special high-grade raw or Pasteurized milk, satisfactory for the use of children and invalids, an ordinary grade of raw or Pasteurized milk suitable for general use, and a poorer grade, called cooking milk, which was to be used as indicated in the name applied. The use of this system of grading in New York City very quickly resulted in the elimination of all of these grades except grade A raw, grade A Pasteurized, and grade B Pasteurized, and a similar situation developed in several other cities in the State when they put the grading system into use.

The foundation of this grading system has been the development of suitable laboratory methods and facilities already mentioned. At first, as stated above, the dairy score was made a large element in the grading systems, and still remains nominally in the State-wide system. It has, however, been evident for a long time that the grading of the milk must rest fundamentally on the quality of the milk itself. For this reason, the New York City Department of Health no longer scores its dairies on a percentage basis. Certain requirements of construction and methods must be met before the dairy is permitted to send milk into the city, but beyond this it is a question of the quality of milk produced.

To anyone who is unfamiliar with the progress that has been made in the dairy sections of the United States in the care of milk on the farm and its shipment for long distances, the high standards set will be a great surprise. There will be few to challenge the statement that the people of New York City receive daily the greatest supply of high-grade milk delivered to any group of people in the world.

With the shift in emphasis from a dairy control which dictates to the dairymen, the form of dairy construction, and methods that he shall use, to one which permits him to follow the system that he finds best suited to his individual needs, provided only that he shall deliver milk of a certain specified standard of food value, healthfulness, cleanliness, and keeping quality, free from objectionable odors and flavors, some of the distrust of the dairymen for the good sense and even honesty of the dairy inspector is passing away. At the same time the dairyman and the milk dealers have learned to value the grading of their product, which permits high quality goods to secure proper recognition in the city markets.

Unfortunately there still remain certain foolish regulations, imposed by municipalities on the assumption that the dairyman is an

⁴ See the Sanitary Codes published by the New York City and the New York State Departments of Health for the details of this grading system. Also N. Y. Agr. Exp. Sta. Bull. 438. 1917.

unintelligent, dirty person whose chief tendency is to skim or adulterate his milk. Too frequently these regulations do not permit the dairyman to make use of his own native talent or facilities to produce high-grade milk cheaply. The irritation that exists among honest dairymen at these regulations is decreasing more and more in those cities of the State where laboratory facilities and equipment are sufficiently adequate to provide a real control based on the laboratory examination of samples of milk.

Under these conditions the regulations imposed on the dairyman can be reduced to the following simple and yet adequate requirements:

a. That the milk should come from healthy animals as shown by an examination by a competent veterinarian.

b. That the milk be kept free from cow hairs, dirt, and other sediment from the time it is first drawn till the time it is delivered into the hands of the consumer.

c. That the utensils, strainers, and all other things with which the milk comes in contact shall be so thoroughly cleaned and sterilized that they shall not add more than a minimum number of bacteria.

d. That the milk be kept free from objectionable odors and flavors whether these may come from feed or from absorption after the milk is drawn.

e. If the milk is to be used without Pasteurization, then additional precautions shall be taken to prevent the entrance of bacteria pathogenic to man.

f. Sufficient cooling shall be used so that the number of bacteria shall not exceed the standards specified for milk of any particular type or age.

For the ordinary dairyman who is prepared to meet the requirements noted above, there should be no difficulty in continuously producing a milk having a count of less than 50,000 per cubic centimeter by the official agar plate method. In fact, the count should normally be less than 10,000 per cubic centimeter.

If these requirements are adequately supported by the proper veterinary and laboratory control, there is no need to dictate to the dairymen the type of stable he shall build, the care he shall take regarding dirt and dust, the type of milk pail he shall use, the temperature to which he shall cool his milk, and the like. If he does not care for these things properly, he can not meet the standards set, and his milk will be rejected. The burden is thereby placed on the producer to use good equipment and methods, while at the same time he is permitted to use his business ability in producing high-grade milk cheaply, thereby benefiting both himself and the consumer.

During the past eight years I have been in charge of the milk-control work for the city of Geneva and have gathered data on the bacteriological quality and temperature of some 40,000 samples of milk. Out of every 5 cans of milk which would have been rejected on the basis of a temperature above 60° F., 2 cans would have been of excellent quality from the bacteriological standpoint. For every 4 cans of milk accepted on a basis of temperature alone, 1 of the cans would have been of very poor quality from the bacteriological standpoint. In other words, a thermometer is not a satisfactory instrument with which to determine the bacteriological quality of milk.

The following will answer the question just asked regarding the extent of the use of direct microscopic examination of milk. Recently we have secured a record of some 15 bacteriological laboratories in New York State, maintained by milk companies. These are analyzing milk as received from the farmer. The 15 laboratories are analyzing about 300,000 samples per year by the plate method, the results being used largely as a basis for the payment of premiums at grade A milk stations. The direct microscopical method is being used largely at the grade B milk plants to determine the quality of the farmers' milk, and the number made per year in these laboratories is about 150,000. It is stated that one milk company is making about 10,000 of the microscopic examinations per month.

Those of you who are going on excursion 4 to-morrow will have an opportunity to examine the work done in the Geneva City Milk Control Laboratory, where the microscopic method is used in controlling the quality of milk as received at pasteurizing plants. About 6,000 samples of milk are examined yearly by the microscopic method in this laboratory. The method is also being used extensively in many States other than New York State.

Chairman ROADHOUSE. The paper is open for discussion.

Prof. C. HOLMES DENHAM (College of Science for Ireland, Dublin). We are very much interested in Doctor Breed's paper, following as it does that of Doctor Orla-Jensen. This method of the bacteriological control of the samples of milk collected through a country must always be the final adjudication; that is, in other words, the quality of the milk.

I was quite distressed when a member said earlier in the morning that the object in England was to improve the worst milk and get it to a higher grade. That is in error. I am afraid that that is impossible from a bacteriological standpoint. Bad milk is bad milk, and you can not make it good milk. You must give your grade A milk the reward for being good milk. You can bring the bad milk up to a higher level only by going to the proper source and improving the quality of the milk at the very beginning. That is the only way. There is no use giving a government a chance to say that this milk is not absolutely poison. That is just what you do if you eliminate the bad. We hear of getting cooking milk for a few cents a quart, and the better people get the best quality of milk. I would like to have Doctor Breed go into that further at a later time if possible.

Chairman ROADHOUSE. Any further questions?

Doctor HAMILL. I have noticed that in all the discussion on the bacteriology of milk no reference has been made to the coli-form organisms. Might I ask Doctor Breed to give us his opinion as to the value of the examination for this form of organism.

Doctor BREED. I had the pleasure of discussing this question with several English and French bacteriologists during the past year. In both England and France I found that the colon test was used extensively. I believe there are few laboratories in this country that use the colon test for milk.

My own feeling about the colon test can be summarized in this way: That if it is made from milk as it comes from the farm the

result may have a rather close relation to cleanliness, particularly to the visible dirt content of milk. But if the test is made 12 hours or longer after the milk is drawn, the question of growth enters into the matter to such an extent that the test loses the greater part of its significance. There is no way of knowing whether the organisms present indicate that the milk has been kept at a warm temperature or whether it was originally produced under dirty conditions. The exact source of the colon organisms in milk is also not entirely clear. In some tests made recently, we have found quite a large number of the coli-form organisms present in the dairy utensils, and others have reported the same thing. Other sources for coli-form organisms which do not indicate manurial contamination have also been noted.

Chairman ROADHOUSE. If there is no further discussion, we will pass to the next subject, "Milk service in cities," by Mr. G. J. Blink, secretary, Union for Dairy Industry and Milk Hygiene, Holland. [Applause.]

MILK SERVICE IN CITIES.

G. J. BLINK, secretary of the Union for Dairy Industry and Milk Hygiene, The Hague.

The question of serving the cities with their milk requirements is a many-sided subject. Many technical and scientific details are concerned in the solution of this problem. To begin with, the milking must take place according to the principles of hygiene and with as much cleanliness as circumstances will allow. The transport of the milk from the farm to the city is an equally difficult and important problem, the solution of which is continually occupying attention; and then, in the handling of the milk and its distribution, other questions have to be considered. All this to one side, I will discuss another side of the subject, which, I am convinced, is the most important, because the manner in which it is treated can have its influence on all the rest of the problem.

In considering this side of the question, it is of the utmost importance to bear in mind that the milk should be delivered to the consumer in such a condition that the extremely dangerous qualities which milk can possess are avoided or neutralized as much as possible. There have been, undoubtedly, so many advances made by the technical and scientific world that it is possible to do this. Of course, one could assume the position that it should simply be left to the trade to distribute milk which complies with the necessary requirements, and that the consumer should make such demands as to the quality of the milk which he receives that the distributing dairies are forced to deliver to him good-quality milk. This standpoint is undoubtedly the simplest, and would for that reason be supported by us, too, were it not that in the case of milk there is a special circumstance which makes it impossible to leave its distribution entirely in the hands of the uncontrolled trade. This circumstance is that the consumer is not in a position to judge sufficiently of the quality of the milk which he gets.

It is obvious, for instance, that for the consumer, milk which is strongly contaminated with tuberculosis is of much lower quality

than milk which contains none of this infection. But how can the consumer determine their presence or absence? We can safely say that this is practically impossible. In order to make the necessary examination of the milk, certain apparatus is necessary and a scientific knowledge which not one consumer in a hundred possesses. The majority of the consumers are not even aware of the possibility that milk contains the infection, while only very few of them are conscious of the fact that they and their children—and particularly the latter, are incurring danger of being infected by them.

I think that this one example is sufficient. Although there are a good many more which could be given, they all point to the same fact: The consumer can judge to only a very limited extent of the quality of the milk. Although this fact will not prevent those among the distributing dairies who are aware of their responsibility from delivering milk of the best quality, it is undoubtedly true that the above-named facts have an undesirable effect on the development of milk distribution. In many instances, an improvement of the quality of the milk would have the immediate effect of increasing the cost of production for the distributing dairies; a dairy which takes the trouble to institute improvements will often increase its own cost price. In many cases it, therefore, would have to raise its prices above those of another dairy which does not take so much trouble. As the consumer can not notice sufficient difference in quality, he will undoubtedly often patronize the dealer who sells most cheaply.

The fact that the consumer can not sufficiently judge of the quality of the milk from all points of view is resulting, therefore, in unfair competition between milk of inferior and milk of better quality.

One way of partially avoiding this would be to give the necessary information to the public and teach them that it is really in their interest to buy milk of trustworthy dealers, even if they have to pay somewhat more for it. Although I believe that better information for the public than is at present given is very desirable, there still remains one great objection: Each distributor will of course say that he is the most trustworthy, and then the public would have to decide who of them is to be believed.

Practical men have tried to find a solution for this difficulty. Several distributing dairies have employed doctors, chemists, or bacteriologists to control the handling and the quality of the milk. But this solution is not sufficient, at least in so far as experience shows in the Netherlands. The public thinks—and is very likely quite right in a good many cases—that they can not put much value on this control by people who are paid servants of the dairies.

We must therefore look for another solution, because it is necessary and of general interest that the consumer should have the opportunity of deciding on trustworthy and impartial evidence, which dairy delivers good and which delivers bad quality milk. Only then will the consumers receive the necessary direct protection, and only then will those circumstances be removed, by which unfair competition of bad milk prevents or retards improvements in those dairies which really want to introduce them.

I am convinced that by whatever means the attempt is made, some sort of legal assistance of the authorities will be necessary

and I think that this assistance is even desirable, because the authorities represent the general interests of the consumer, so that the latter can base his preference on a control which has received the sanction of the authorities. I must, however, immediately add to this that the interference of the authorities must be restricted to the necessary minimum, and that it should be the aim to let the improvement of the product and the supervision emanate from, and be carried out by, the distributing dairies themselves. I believe that in the following plan proper consideration has been given, as far as this is possible, to both these and all other reasonable requirements. This scheme can of course be worked out in accordance with the circumstances of each special case.

I. The authorities assume power by law to give milk which is under special supervision a special name: for instance, "controlled milk." At the same time it must be demanded that milk which is not under this control must be sold under another name; for instance, "uncontrolled milk."

II. The distributing dairies form an institute of which they all can be members if they comply with certain conditions to be prescribed by the institute. The proposed institute exercises an intensive supervision to insure that their conditions are adhered to.

III. The authorities give to members of the above-named institute the power to call their product "controlled milk" (see I.). The authorities, at the same time, decide that those who are not members of the institute may only sell milk, which is called "uncontrolled milk."

IV. While the authorities, according to III, would give a concession to the institute, they would assume the right of supervising its work. For instance, they might have power:

a. To appoint one or more delegates in the institute.

b. To give or withhold their approval of the conditions which the institute imposes upon its members.

c. To exercise supervision over the control which the institute carries out.

In this plan only the principles have been specified. The executive work will naturally require proper consideration of all special circumstances. The requirements of hygiene and the principles of food values would naturally have to be considered, but it would also have to be considered whether all proposals which seem desirable from a theoretical standpoint are also in every way practical.

I believe that thus an indication has been given of a practical and economic way which may bring an end to the very undesirable condition, which still exists in many countries, and amongst others the Netherlands, viz.: that competition in milk distribution, which is insufficiently attended to, acts as a strong brake upon the improvements in the milk business in accordance with modern technical and scientific ideas. As soon as this fundamental question has been settled, I believe that the results of scientific and technical improvements in milk distributing will be far more quickly and generally adopted than they are at present.

Chairman ROADHOUSE. Are there any questions on this paper? If not, we will pass to the next paper, which is given by Mr. R. M.

Allen, director, research products department, Ward Baking Co.; his subject is "The necessity for legislative control in the sale of milk breads." Mr. Allen. [Applause.]

THE NECESSITY FOR LEGISLATIVE CONTROL IN THE SALE OF MILK BREADS.

R. M. ALLEN, director, research products department, Ward Baking Co., New York City.

Mr. Chairman and Gentlemen: Friday of last week, in one of the sessions, I told a group about the use of milk in bread.

I outlined the composition of a loaf of bread that had been built up with about 10 per cent whole milk, based on the weight of the flour, plus an extract made from the whole wheat. Such a loaf of bread has produced normal growth in test animals, whereas animals fed on the average good market breads die from within two to three months. This loaf, as the sole diet, with water, not only has produced normal growth, but reproduction, already, into the eighth generation, with white mice.

It is desirable from all standpoints, particularly those of economy, palatability, and nutrition, to distribute milk, or its equivalent in milk solids, through the loaf of bread. Milk powder can be produced in the regions and seasons of abundance, and distributed at once through the loaf of bread without having to wait on the grocery shelf. More milk may be introduced into the diet of young and old if bread, which is consumed three times each day, is made with milk.

Now that we have found that whole milk can turn whole wheat into a balanced food, State and Federal regulation should require a standard for milk breads, or require that the amount of milk incorporated in the bread be stated when it is said that milk has been used in the manufacture of the bread.

This can be done in two ways: (a) By specific statutes, and (b) by regulation under general and existing statutes. The first question is to determine the amount of milk to be required before a loaf may be called "milk bread." The second question is what descriptive terminology shall be allowed when skimmed milk solids are used.

In 1906, an arrangement was made whereby the committee on food definitions and standards, appointed by the Association of State Dairy and Food Departments, a committee appointed from the Department of Agriculture and one from the Association of Official Agricultural Chemists were combined into one committee of nine. This committee promulgated, in 1922, a standard for milk bread, requiring that at least one-third of the liquid content shall be whole milk. It will be recognized that this is a low standard. but it was also felt that if this standard could be put into practice it would include a large amount of whole-milk solids; and that the standard could be increased when the movement for standardization of milk bread was once started.

If it is possible for the dairy and baking industries to reach an agreement on this subject with the Government officials, such agree-

ment, based on results of nutritional studies, the amount of milk contained in the loaf, in order that it may be sold as milk bread, can be written into Federal and State laws. When a standard has been finally adopted, it is far easier of enforcement if it is written into statute. But if the amount of milk can not be agreed upon, then the United States Department of Agriculture and the States should be given more specific authority for the adoption of standards giving the amount of milk to be contained in milk bread. The dairy industry, because of experience in litigation over standards and the change of standards with changing administrations, will prefer the statutory standard. If such a standard is formulated and included in the laws, the industry should see that it is uniform throughout the States, since bread is entering more and more into interstate commerce, and a milk bread legal in one State should be equally legal in another.

The proteins and salts of the skimmed milk, separated in the production of butter, splendidly balance the proteins, salts, and carbohydrates contained in the wheat. It would greatly increase the nutritive value of bread if all of these solids and salts separated in the production of butter could be used in baking. But in order to do this, some terminology must be devised which will point out the increased nutritive value to the consuming public, and, at the same time, not trespass upon what the consumer has a right to expect when the term "milk bread" is used. Skimmed-milk solids contain valuable proteins, salts, lactose, and everything that the milk contains, except the fat and vitamin A. Animal feeding tests with a bread made with skimmed-milk solids would show a decline because of the absence of vitamin A, whereas the addition of butterfat to the diet would change the growth curve from a downward to an upward curve.

But with added cost to the loaf, there must be some way by which the added nutriment can be accurately described to the public, so that it will willingly pay for the necessarily increased cost.

If milk bread is controlled by standards, this can be done by regulation by adding a clause to section 3 of the food and drugs act of June 30, 1906, investing the Secretary of Agriculture with the power to make the necessary rules and regulations with a provision for the proper standards to be applied to the making of milk bread.

It is important to have an analytical method to determine accurately how much milk has been put into the bread. A tentative method has been worked out by the Ward Laboratories, cooperating with the laboratories of the Ohio State Department of Agriculture. This method is as follows:

Fifty to sixty grams of fresh or air-dried bread (crumb only) are digested in distilled water at about 40° C. for one hour. Add approximately 20 grams of filter cell and centrifuge. Pour off the clear liquid, add more water to the residue, and stir vigorously and centrifuge a second time. Combine the clear liquid. Filter through double filter paper, with a layer of filter cell about a quarter of an inch thick (a suitable arrangement for this is a large Buchner funnel with suction). Add small quantity of water to the original residue and pour the entire charge on to the funnel last. Combine the clear

filtrate and add 35 grams of starch-free yeast,¹ and warm to 80° F.; also add approximately five-tenths of a gram of ammonium sulphate, and aerate by means of compressed air for at least two hours; at the end of this period make up to 1,000 cubic centimeters, filter, and without any further preparation determine the lactose by means of the gravimetric copper reduction method. Two hundred to three hundred grams of finely ground air-dried bread, depending upon the fat content, are placed in a two-liter flask containing 1,000 cubic centimeters of distilled water and 30 cubic centimeters of hydrochloric acid. The mass is digested by boiling for one hour, or until it shows good digestion. Ten grams of filter cell are then added to the cooked mash. This is filtered through a Buchner funnel containing a filter paper upon which is a thin pad of filter cell. Apply suction until the mass is fairly dried. Transfer the residue to a beaker, stir with ether, filter again through filter cell into a dry flask. Evaporate the ether, and if the oil is clear it is ready for the Reichert Meissel number.

During the last 10 years the science of nutrition has advanced rapidly; it is of great importance to the better and more economic feeding of young and old. In every single laboratory, in every animal and human feeding test, the balanced food value of whole milk and whole cereals has been established. We waited a long time from the pioneer work of Pasteur to put preventive medicine into effect. We waited many years before we enacted and enforced laws requiring purity in foods and honesty in the labeling. We waited many years before sanitary standards were enforced throughout the production and sale of foods. Now, do not let us wait as long to put the sound and important facts about nutrition into practice.

Chairman ROADHOUSE. Is there any discussion on the subject?

Mr. ALLEN. I might add that I believe if you can stimulate, in this country, the use of milk in making bread there will be created a new demand for milk equal to that of the butter or cheese industry.

Chairman ROADHOUSE. We have several papers remaining. The next, "Standardization applied to the sterilization of milk bottles," is presented by Dr. J. H. Shrader, director, and Mr. R. S. Craig, assistant director, Bureau of Chemistry and Food, Health Department, Baltimore, Md. I understand Mr. Craig will read this paper.

STANDARDIZATION APPLIED TO THE STERILIZATION OF MILK BOTTLES.

J. H. SHRADER, Ph. D., director, and R. SEWELL CRAIG, assistant director, Bureau of Chemistry and Food, Health Department, Baltimore, Md.

The current records of the Bureau of Chemistry and Food of the Baltimore City Health Department disclosed marked inconsistencies in bacterial counts of washed and sterilized bottles as collected by the routine system of sanitary control. These inconsistencies varied from a few excessively high bacterial counts

¹Thirty-five grams of yeast displace 35 cubic centimeters of water; therefore, a correction of 35 cubic centimeters must be made.

among a series of passably good counts in some cases, to the most persistently offensive character of work in others. Dealers, when reprimanded by the bureau, repeatedly denied any negligence on their part and placed the blame rather upon the failure or inefficiency of the bottle-washing and sterilizing machinery. Upon casual inspection there appeared to be some grounds for the attitude of the dealers, although from such a necessarily brief observation very little was definitely disclosed. It might be quite possible, in other words, for an inspection to show that a dealer was operating his machine exactly in accordance with the prescribed technique at the time of inspection without shedding the least light upon his general practices.

Pursuant to the policy of cooperating with the dealers in effecting reasonable control, it became necessary to study the dairy trade practices in order to place the subject of bottle washing and sterilizing upon a basis of sanitary control in some measure appropriate to its recognized importance as a public health factor. Accordingly this investigation was directed to a study of the following points:

1. The improvement of those steps in the processes of cleansing and sterilizing bottles which limit the efficiency of bottle-washing and sterilizing machinery.

2. The determination whether the inconsistent and unsatisfactory results of sterilizing bottles were due to faulty machinery or to improper methods of operating the machines.

3. The effect of short storage upon the bacterial counts of washed and sterilized bottles.

4. The setting of a numerical bacterial standard by which the relative cleanliness of bottles might be judged.

In the 49 dairies in Baltimore, there were but four essentially different methods of washing and sterilizing bottles, three by means of machines and one by hand. A number of the machine types were practically identical in operation but, being made by different manufacturers, varied slightly in some details of construction. However, in order to broaden the experimental work, there was included within each group the machines of all manufacturers and accordingly experiments were conducted with 13 different methods and machines.

The characteristics of the four essentially different methods may be summarized as follows:

1. Electrically driven hydraulic bottle-washing and sterilizing machines with preliminary cold-water rinse. Bottles are inverted and subjected to four operations: First, strong individual jet of cold rinse water for about 10 to 15 seconds; second, individual jet of hot alkaline solution at temperature 130° to 150° F. for 20 to 84 seconds; third, individual jet of hot rinse water at temperature of 140° to 200° F. for 15 to 84 seconds; and, fourth, individual jet of steam from boiler (pressure, 40 to 100 pounds) for 10 to 15 seconds.

2. Electrically driven hydraulic bottle-washing and sterilizing machine (without preliminary cold-water rinse). Identical with above machine with omission of cold-water rinse.

3. Electrically driven machine which conveys bottles through hot alkaline solution at temperature of 105° to 130° F. for 10 minutes, followed by brushing outside and inside for about 6 to 10 seconds.

Bottles are then rinsed with cold water, and finally subjected to dilute solution of sodium hypochlorite for about 5 to 10 seconds.

4. Hand washing and sterilizing. Bottles are soaked in soap or soda solution for 10 to 30 minutes, and then brushed by machine, or in some instances by hand. Bottles are then inverted over individual jets of hot rinse water at temperature about 175° to 180° F. for from a half a minute to 3 minutes, followed by steaming for 1 to 20 minutes (boiler pressure, 20 to 80 pounds).

In carrying out the field studies, care was exercised to maintain all solutions, washes, and rinse waters at proper temperatures, and to provide sufficient steam pressure and flow, and to have the machinery placed in good running order. Under such conditions the experiments were carried out without interfering with the dairy routine by any undue delay in washing and sterilizing bottles.

After the washing and sterilizing, the bottles were stored for lengths of time varying from 1½ to 24 hours. In every case they were stored in inverted position just as they were taken from the steam sterilizer. No separate storage room was provided in any case, the majority of the dealers stacking the crates in the room occupied by the bottle-filling machinery, without particular attention to ventilation.

Bottles for laboratory examination were taken from the bottle cases, after the process of cleaning was well under way, in order to allow for the exigencies of dairy practice, and to preserve as closely as possible the usual working conditions of the machine. Four bottles were taken diagonally across a given case just as it emerged from the machine. The following case was marked, and at the end of the storage period was likewise sampled diagonally. In order to learn something of the nature of the bacterial counts of the bottles prior to washing and sterilizing, a corresponding number of such bottles were taken at the same time. In all cases the examination was carried out by agitating 10 cubic centimeters of sterile water in the bottles and plating 1 cubic centimeter portions with standard agar.

The bacterial results are summarized as follows:

	Methods.			
	No. 1.	No. 2.	No. 3.	No. 4.
Number of bottles examined.....	36	52	12	60
Average bacteria count per bottle.....	54	30	15	25
Maximum bacterial count.....	900	320	40	700
Minimum bacterial count.....	0	0	0	0

Dirty bottles (before washing and sterilizing).

Number of bottles examined.....	140
Average bacterial count per bottle.....	300,000
Maximum bacterial count.....	2,400,000
Minimum bacterial count.....	20

Bottles after washing and sterilizing.

	Number of bottles.	Per cent.
Sterile.....	47	27
Bacteria per bottle:		
Between 1 and 10.....	59	33
Between 10 and 25.....	32	18
Between 25 and 50.....	20	11
Between 50 and 100.....	9	5
Between 100 and 200.....	4	2
Above 200.....	8	4
Total.....	179	100
Maximum bacterial count, 900.		

Bottles after storage.

	Number of bottles.	Per cent.
Sterile.....	41	26
Bacteria per bottle:		
Between 1 and 10.....	45	28
Between 10 and 25.....	31	19
Between 25 and 50.....	16	10
Between 50 and 100.....	9	6
Between 100 and 200.....	9	6
Above 200.....	8	5
Total.....	159	100
Maximum bacterial count, 660.		

It is apparent from the above bacterial data that the general excellence of the results leaves little opportunity for the recommendation of any particular method of washing and sterilizing bottles or of any type of machine, when reasonably approved practice is followed. Accordingly, the matter of securing satisfactory results is largely if not wholly dependent upon the manner in which the washing and sterilization is carried out, particularly upon the temperatures of the washing, rinsing, and sterilizing baths.

During January, 1921, considerable difficulty was experienced with high bacterial counts of Pasteurized milk as delivered to the consumer. The source of the trouble was caused by ineffective washing of the bottles and was located in the counteracting influence which the low temperatures of the bottles (and in some cases even the ice) exercised upon the temperature of the alkali used in washing the bottles and upon the steam sterilization which followed. At times, bottles carried frozen milk far into the cleansing machinery. In the present case a parallel weather condition was encountered. It appeared, however, that by paying strict attention to the temperature of the baths, this difficulty may be effectively obviated.

The most important single factor observed to be detrimental to effective washing and sterilizing of bottles was the use of insufficient temperatures, both in the washing and rinsing baths and in the subsequent application of steam. Closely related to this feature is the deplorable ignorance of dairy attendants upon the

subject. It appeared to be the common understanding of the average attendant that apparent cleanliness, followed by a fleeting and untimed application of steam, was all that was to be desired in washing and sterilizing bottles. Other attendants more bent upon financial considerations deliberately avoided higher temperatures, particularly in the application of steam, through the fear of excessive breakage.

In the first case the trouble lay in allowing the washing and rinsing baths to cool by the introduction of bottles without any compensating application of heat. Following this, it was found that insufficient heat was being applied in the steaming process by the use of hand-controlled steam valves which were only partly opened and thus admitted only a small amount of steam, regardless of the pressure observed on the boiler. In such cases, while the bottles were frequently found to be apparently clean, they came from the steam sterilizers insufficiently heated, often only lukewarm, and accordingly containing large numbers of bacteria.

The breaking of excessive numbers of bottles during steaming is due principally to the rapidity of the change of temperature of the glass between successive treatments, rather than to any prolonged action of the steaming temperature, as appears to be the common belief among dairy attendants. Excess breakage by heat was corrected by simply grading the temperature of the two preceding baths so as to minimize the heat shock to the bottles in the final steaming. To this end a temperature of 140° F. was selected for the wash containing the soap or soda solution, and a temperature of 185° to 190° F. for the hot water rinse, followed by the steaming at something above 212° F. An application time of at least three-fourths minute in each case—that is, for the washing, rinsing, and steaming—yielded the excellent bacterial results recorded above, and it was found that these temperature and time factors were both practical and efficient as well as economically advisable.

It appeared that the quantity of soda or washing powder present in the wash water had little influence upon the final bacterial count. The quantity of free alkali, sodium carbonate, and sodium bicarbonate was estimated in the wash waters from each dairy, but there is little, if any, relation to the final bacterial counts in the sterilized bottles. From data and observation, it is believed that the potent factors in the destruction of bacteria lie in the time and temperature standards as described above, and that any other influence, such as the concentration of alkali in the wash waters, would be of a minor character and obscured by more powerful forces.

It is essential to use a sufficient quantity of some alkaline washing powder or compound, sal soda, etc., in order to soften and remove the dried cream and albumin adhering to the dirty bottles and to saponify the fat and thus to enhance the efficiency of the subsequent operations of rinsing and steaming. In this respect we experienced some slight difficulty in several dairies that insisted upon using the same wash water over too long a period without refreshing either the solution or replacing the alkali consumed in operation. The result was that bottles were being removed from the washing bath not entirely free from an adhering coat of dried casein and albumin,

which the subsequent rinsing likewise failed to remove, and which protected the accumulated bacterial growths during the action of the final steaming. In these cases a change of solution and the addition of fresh washing powder readily corrected the difficulty. Thus it would appear, as we have stated, that while it is essential that all physical dirt be thoroughly acted upon in the washing bath and either removed or softened, this operation, although closely related, is actually subordinated to the process of hot rinsing and steaming for the destruction of bacteria.

It appears from the foregoing that the principal difficulty heretofore experienced in obtaining satisfactory bacterial counts has related to faulty methods of operating rather than to any great defect in the construction or arrangement of the machinery, in view of the fact that practically the only changes which were made from the usual, dairy routine method of sterilizing bottles related to corrections and improvements in the method of operation. There are, however, several points regarding the construction of the machinery which may be criticized as having a direct bearing upon this subject.

Probably the most important machine defect was the clogging of the steam injector jets with dirt or rust which effectually prevented the steam from reaching that particular bottle which happened to be over that particular closed jet. Closed steam jets were found to be a very common fault. It is a matter very easily remedied, but quite important nevertheless. Careful inspection to correct this fault has yielded good results in improving the performance of many dairies.

Another mechanical difficulty was observed in the rinse-water injector operation. It was found that the force of the stream of water was so great in some cases that the inverted bottles were lifted from their position and deposited, usually horizontally, on top of the other bottles in the crate. Thus such bottles escaped all of the subsequent operations, including the steaming, and came from the machines not only unsterilized, but in some cases actually dirty. This condition should be remedied, not by cutting down the force of the water, but by placing a protection over the crate of inverted bottles in order to hold them securely in position. In some machines of a later model, a plate acting as a hinged roof has been installed to take care of this feature. The plate hangs vertically at rest and is moved to a horizontal position by the crate as it passes through the machine. The plate rests upon the crate during the operation and falls to the vertically hanging position as the crate passes on to the next operation. Some such improvement should be installed upon the other models, or the roof of this part of the machine should be lowered so as to prevent the bottles leaving their position during this process. It is a serious objection when the force of the water is great.

Upon referring to the summary of the bacteriological data, it will be found that of a total of 179 bottles examined—

- 27 per cent contained no bacteria,
- 60 per cent contained 10 or less bacteria per bottle,
- 78 per cent contained 25 or less bacteria per bottle,
- 89 per cent contained 50 or less bacteria per bottle,
- 94 per cent contained 100 or less bacteria per bottle,
- 96 per cent contained 200 or less bacteria per bottle.

while there were only 8 bottles, or 4 per cent, that contained more than 200 bacteria per bottle. The maximum count which was found in any bottle was 900 bacteria per bottle.

In view of these figures, and from the fact that these results were obtained under conditions easily attainable in any dairy, it seems reasonable to require that 4 sterilized bottles out of every 5 collected should contain no more than 200 bacteria per bottle.

The data upon bottles after varying periods of storage show a close resemblance to the figures on the freshly sterilized bottles. Of 150 bottles examined—

26 per cent contained no bacteria,
54 per cent contained 10 or less bacteria per bottle,
73 per cent contained 25 or less bacteria per bottle,
83 per cent contained 50 or less bacteria per bottle,
89 per cent contained 100 or less bacteria per bottle,
95 per cent contained 200 or less bacteria per bottle,

while only 8 bottles, or 5 per cent, contained more than 200 bacteria per bottle. The maximum count was 660 bacteria per bottle.

In view of the similarity of these counts to those of the freshly sterilized bottles it is reasonable to require that the maximum limit of 200 bacteria per bottle be extended to include bottles freshly sterilized and also those from storage; in other words, at any time prior to use.

The condition of actual sterility is not, of course, consistent with the economics of dairy practice nor, on the other hand, is it believed to be demanded by public health considerations. By a sterile bottle, in the sense that it is employed throughout this paper, is meant freedom from those organisms which cause or are likely to cause illness either through their own specific agency or through their metabolic products when grown in the medium of milk. It is with this in mind that the toleration of 200 bacteria per bottle is recommended. It will be remembered that in establishing a numerical bacterial limit for Pasteurized milk the principal consideration—the destruction of pathogenic bacteria—is based upon two factors, the thermal death points of such organisms and the reduction in total numbers of bacteria present in the raw milk. It is assumed that a great reduction in total numbers of bacteria will necessarily include the more sensitive pathogens. It is felt that a consideration of the same principles applied to the problem of sterile bottles would amply justify the numerical standard. The average number of bacteria found in bottles before washing and sterilizing, according to the foregoing results, is about 300,000 bacteria per bottle, with a maximum count of 2,400,000. To reduce this number to 200 bacteria per bottle for 4 sterilized bottles out of every 5 collected seems consistent with the most exacting public health requirements, and, as demonstrated, with good dairy practice.

CONCLUSIONS. .

1. Ignorance of the principles of bottle washing and sterilizing is the leading cause of the failure of dairymen to accomplish satisfactory work.

2. Two mechanical faults most commonly found in bottle washing and sterilizing machinery were closed steam jets and the lack of a device to hold inverted bottles in position during the process.

3. The storage of bottles after washing and sterilizing as practiced by dairymen does not result in the growth of bacteria in the bottle.

4. A numerical standard of not over 200 bacteria per bottle in washed and sterilized bottles is recommended, this to apply both to freshly sterilized bottles and to bottles after storage. As a regulatory consideration, it is further recommended that in a series of bottles examined from any dairy at least 80 per cent of the samples conform to this standard.

Chairman ROADHOUSE. Is there any discussion? If not, we will go on to the next paper, "Sterilization of milking machines." This paper was prepared by Dr. R. S. Breed and Mr. A. H. Robertson, both from the New York Agricultural Experiment Station at Geneva. Mr. Robertson will present the paper.

STERILIZATION OF MILKING MACHINES.

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While milking machines have been tested experimentally for many years in North America as well as in other parts of the world, it was not until about 1910 that they began to attract the serious attention of American dairymen. From that time until about 1916, there was an increasingly rapid introduction of machines on dairy farms, which reached a climax in 1917 and 1918, when war conditions caused an acute shortage of labor. With the return of the American Army to civilian pursuits, and the necessary readjustment of business following these years, there was a sudden dropping off of sales and many users discarded their machines. However, if one may judge from the number of machines exhibited at the present National Dairy Show, as well as from conditions observed in the field, the dairymen are again buying machines. This is apparently due to the recent increase in price and growing scarcity of satisfactory labor, a condition which forces the introduction of labor-saving machines. To-day, milking machines are found in common use in all of the dairy sections of the United States and Canada. A little thought will show that the prolonged use of milking machines on dairy farms in America must prove their practical utility, when they are operated intelligently. Under American conditions, the dairymen would never continue to use machines if they caused a diminution in the milk flow or caused injury to the udders.

Perhaps the one thing which has most greatly influenced the development of milkers in North America has been the almost universal insistence of public health workers that market milk be so cared for that it has a low bacterial count. This has caused extensive investigations of convenient methods of sterilizing milkers. It is the purpose of this paper to discuss the results of these investigations in the light of the practical experience of American dairymen, and in particular those of New York State.

The most natural thought in connection with the cleaning of any dairy utensil is that of scrubbing it, following this procedure by scalding with hot water or sterilizing with steam, and completing

the cleaning process by drying. It is therefore not surprising that practically all of the early investigators of sanitary methods of cleaning milking machines (Harrison (6); Stocking (12); Stocking and Mason (13); Edwards (3); Meek (9); Haecker and Little (7); Harding, Wilson, and Smith (5); Hoffman-Bang (8); Williams, Golding, and Mackintosh (14); Burri and Hohl (2), and others) tried this method for milker tubes. Where the heat used was less than the amount necessary to kill the microorganisms present, or where other sources of contamination were left uncontrolled, the results were very unsatisfactory. The bacterial counts under these conditions were usually high. Where sufficient heat was used to sterilize or practically to sterilize the various parts of the machine, the results reported are better and in several cases excellent. Thus, for example, Edwards (3) reports counts as low as 1,407 and 1,776 per cubic centimeter when the tubes were thoroughly cleaned, boiled, and steamed.

Practically all of the earlier investigators who have used heat sterilization mention the fact that the rubber parts are so rapidly destroyed as to make this method of sterilizing milker teat cups and tubes by boiling water or by steam, impracticable under ordinary conditions.

With the wonderful growth of the American rubber industry, and the development of heat-resistant rubbers for use in surgical gloves, automobile tubes, and other things, this situation has changed. Several rubber manufacturers are now supplying rubber parts for milkers that are designed to withstand boiling water or steam without injury. This is particularly true of cloth-wrapped rubber tubing. One precaution in connection with the heating of rubber parts in water or steam which has been found to prolong the life of the rubber parts materially has been to separate the rubber from the metal parts before heating them. If this is not done, the heat tends to vulcanize the rubber in the stretched form. In a short time the elasticity disappears, causing leakage of air and the teat cups to fall apart when in use.

In view of the fact, however, that several of the standard makes of milking machines in general use on dairy farms are not yet satisfactorily equipped with heat resistant rubber parts, it is unfortunate that sweeping statements have been published as to the general applicability of the heat-sterilization method for cleansing the teat cups and tubes of milking machines. Some investigators have even gone so far as to assert that this method of sterilization is the only method that can be used with good results.

Because of the difficulty in getting rubber goods of the right quality for use where heat sterilization was to be used, investigators have, from the first, tried to secure satisfactory methods of sterilizing the rubber parts by means of chemicals of various kinds. Thus among the early workers in this field, Erf (4) tried boracic acid, a solution of lime, and formaldehyde. Stocking (12) and Stocking and Mason (13) tried brine, borax, lime water, formaldehyde, and soap powders, while Harding, Wilson, and Smith (5) used brine. From this early work it became evident that brine was the most satisfactory solution that could be used for keeping the tubes sweet and clean, but its use

was accompanied by the difficulty that some metals were corroded by it. Also, it was a preservative rather than a sterilizing agent.

It was not until Ruehle, Breed, and Smith (11) showed that the brine organisms were not capable of growing in milk and that milk organisms were not capable of growing in brine, and Wing (15) showed that brine could be readily and efficiently sterilized by the use of hypochlorites, that the real value of the brine-hypochlorite combination became evident. Meanwhile various firms in the United States of America, which sold hypochlorite solutions, began an active advertising campaign urging that milking machine tubes be disinfected by these solutions used alone. The net result of the latter campaign has been one of great disappointment. While milking-machine tubes can be effectively sterilized by the use of hypochlorite solutions alone, where these are used in sufficient strength, and the solution is renewed with sufficient frequency (11), very few users of milking machines have appreciated the limitations of this type of sterilizing agent well enough to succeed continuously in producing a low-count milk. In those cases where dairymen have neglected these solutions, it has not been uncommon, especially in hot weather, to find a man keeping his milker tubes in a malodorous solution entirely free from any sterilizing agent and filled with enormous numbers of organisms. Probably no one thing has so delayed the successful and satisfactory use of milking machines, resulting in the continuous production of good, sanitary milk, as has this campaign of commercial firms for the use of hypochlorite solutions. Hypochlorite solutions are highly effective for use with a preservative solution like brine, but when used alone they require more attention than the average dairyman can or will give them.

However, the limitations of the brine-hypochlorite solution are such that no recommendation should be given for its universal use. The majority of the teat cups of milking machines are now made of metal parts which are not corroded by this combination; but in certain types of machines, because of mechanical limitations, this has not yet been accomplished with entire satisfaction. Within recent years the so-called chloramines have been put on the market for use as sterilizing agents for milking-machine tubes. These are more stable compounds than the hypochlorites and can be used without salt more successfully. The addition of 10 per cent of salt to the solution makes it still more satisfactory than when the chloramine solutions are used alone, but even this combination has its limitations like the other methods already mentioned.

A third method of caring for milker tubes has also been used quite commonly, and with fair success in New York State where really cold springs are quite common. This method consists of allowing clean, cold water to circulate through and over the milker tubes and cups between milkings. It depends for its success upon general cleanliness and the retardation of bacterial growth through the effect of cold. It is successful only when low temperatures, preferably less than 50° F., are maintained. Because this method of caring for the teat cups and tubes can be used without injury to rubber parts or to the metals ordinarily used, it has been tried in some cases where conditions did not justify its use. It is not a positive method of sterilizing, in that the bacteria are not killed, and

results can never be achieved which are as satisfactory as in those cases where proper heat methods or chemical methods are used. In some cases it has even been observed that certain water-inhabiting organisms, adapted to a low temperature environment, find conditions so favorable for growth in the milker tubes that these apparently clean parts may become the source of incredible numbers of organisms. Nevertheless, there are some men who continuously get good results with this method of caring for milker tubes under farm conditions.

With all the procedures that have been suggested for caring for the tubes, there has been a common tendency for dairymen to rely either on heat or cold or the action of the chemical solution to destroy the bacteria, to the neglect of actual cleanliness. Milk has been allowed to dry on or in the tubes; the teat cup claws have been allowed to become badly clogged with milky accumulations; check valves on the pail cover have been left uncleaned; tubes have been thrown carelessly into the solutions so that entrapped air prevented the action of the sterilizing solution; and many other essentials have been neglected, with the thought in mind that the heat, cold, or chemicals took care of everything.

It was shown early in milking-machine investigations that the tubes and cups could be kept in clean and sanitary condition without taking them apart daily, if they were washed thoroughly by drawing an abundance of cold and hot water, containing alkali cleaning powders, through these parts immediately after each milking (5). The publication of this statement has been used as an excuse by certain milker salesmen and dairymen for saying that all the cleaning necessary was to draw a pail of cold water through the tubes whenever convenient after milking. In many cases this is the only cleaning milking machines have received for months at a time. This has been the case, in spite of the fact that even where the tubes are cleaned thoroughly after each milking, there is always some blackening of metal parts where these come in contact with the rubber, so that to keep them really clean and shining, they must be taken apart and each individual part polished at least once a week. Likewise, the failure of dairymen to realize the necessity for making satisfactory provision for proper conveniences for cleaning their machines has led to the production of large quantities of milk containing excessive numbers of bacteria. The particular convenience most needed where milkers are in use is an abundant and convenient supply of really hot water.

Recently some public health authorities, because of a very natural and well-grounded prejudice against the use of chemical sterilization of dairy utensils, have threatened to forbid the use of chemical sterilization for milking machines. Fortunately, so far as is known to the writer, this policy has never been put into force, and it is to be hoped that it will not be. Health authorities have every reason to be active in compelling dairymen either to produce a clean milk containing few bacteria, or to discard their machines; but any attempt to enforce a regulation forbidding chemical sterilization would take us back to the days when dairymen were instructed by control officials that clean and sanitary milk could be secured only in whitewashed barns, with a specified number of windows, and so on. Under present conditions in the United States, if health au-

thorities dictate what method for cleaning milkers shall be used, or state that only one method is successful, because of mechanical limitations in the construction of milking machines, it gives the support of public agencies to one group of milker manufacturers as opposed to a second group. If there were any danger involved which affected the public health, such a course might well be justified, even though one group of commercial interests were favored; but there is no evidence at present available that indicates such necessity.

Some investigators have not realized the difference between the use of the ordinary chlorine solutions and the use of the brine-hypochlorite solution, or have reported that the latter method was not successful because they knew of instances where dairymen had reported that they were using it with unsatisfactory results. In such a case, as in the instances reported by Bright (1), an investigation would undoubtedly show that the dairyman may honestly think he is following the directions, but is failing to observe some essential step in the procedure.

Inasmuch as it has been amply shown (10) that the chief source of the bacterial contamination of milk is from the dairy utensils with which it comes in immediate contact, and, as literally tens of thousands of dairymen in the United States are using milking machines, the matter of a campaign for better care of these machines is highly important to all of the persons concerned. The public is interested through its agents, the public health authorities, and experiment stations and colleges. The dairymen themselves are interested because any tendency to lower the quality of dairy products injures their business. The milker companies likewise face the necessity of showing that milking machines can give satisfaction in the hands of purchasers of their machines, or their business will disappear.

Now that proved and tried methods of cleaning milkers are known, it would appear that the time is ripe for more vigorous campaign measures by all of these forces to improve a situation that is not what it should be. The milker companies, as already indicated, are individually or collectively organizing campaigns along lines that should command the support of everyone. Some States, such as New York, are carrying information directly to dairymen through extension activities. Some city milk inspectors and inspectors employed by dairy companies are securing correct information regarding these facts, and are disseminating it to the dairymen with whom they come in contact, and some of the dairymen's organizations are taking a real interest in encouraging their members to produce better quality products.

The thing most needed at this time to support this campaign is the further development of the laboratory examination of milk. This would give the control official definite data regarding the quality of the milk produced, so that his action in rejecting undesirable milk can be based on a real knowledge of the actual quality of the milk, rather than on the more superficial information that comes from an inspection of the dairy premises. Proper coordination of these activities would hasten the day when all of the users of milkers will clean and sterilize them properly. In New York State gratifying results are already evident from coordinated efforts along these lines

so that we already have milk plants where educational measures have so reduced the trouble from dirty milking machines that hundreds of users of machines are continuously producing milk with a bacterial count less than 10,000 per cubic centimeter.

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Chairman ROADHOUSE. Is there any discussion on this subject? If not, we will listen to the paper on the subject, "The difficulties encountered and results obtained in enforcing the milk Pasteurization requirements in Baltimore," submitted by Dr. J. H. Shrader and Mr. R. S. Craig, of the Health Department of Baltimore, Md. Mr. Craig will present this paper. Mr. Craig.

DIFFICULTIES ENCOUNTERED AND RESULTS OBTAINED IN ENFORCING THE MILK PASTEURIZATION REQUIREMENTS IN BALTIMORE.

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At the time of the passage of the present milk ordinance of Baltimore, November, 1917, the milk business was in the hands of about 100 delivering dairies, which varied in size from plants handling 5 gallons to those handling 3,000 gallons. These plants were scattered

about the city, and were smaller and more numerous in the poorer and more congested sections. The milk was usually conveyed in 5-gallon cans, and customers were served by dipping directly from the can and pouring into the proffered pitcher or bucket. Some few dairymen served also bottled milk, and these bottles were often capped by hand. One of the cleanest dairies in the city lost its trade through the dissemination, on its routes, of typhoid infection of epidemic proportions, by a typhoid carrier who capped the milk by hand.

During the nineties, a progressive dairyman from Germany began in Baltimore the Pasteurization of milk in the interests of public health. Other local dairymen, one by one, took it up, but practiced it more for commercial reasons, such as improving the keeping quality of the milk. No official regulation of Pasteurization was exercised at this time, with the result that the process suffered all the variations to which a hundred more or less uninformed dairymen could subject it. Often the bacterial count of the milk was higher after it was so treated than it was before. Pasteurization in the early days was accordingly desultory in practice and ineffective in performance.

During this period, an unusual and fatal incident developed in the first Pasteurization plant which operated in Baltimore. The "flash" system of Pasteurization had been in use for some time whereby the milk was heated to 165° F., and held thereat for about two and a half minutes. This treatment was not effective in killing certain streptococcus strains, which resulted in a severe epidemic of so-called septic sore throat. Upon quickly adopting a holding process, whereby the milk was held at 145° F., for 30 minutes, the milk-borne phase of the epidemic abruptly ceased.

An early objection to the enactment of Pasteurization legislation was the claim, raised by many small dealers, that the expense of installing Pasteurization machinery was more than the small dairyman could stand, and the result would be that all the business would go to the large concerns, with the consequent stifling of competition. That this argument was erroneous is shown by Table 1. In this table is presented data of the milk industry for five years immediately preceding, and for the same period immediately following, the enactment of the Baltimore city milk pasteurization ordinance.

TABLE 1.

Year.	Milk entering Baltimore.	Popula- tion.	Per capita con- sumption.		Number of pas- teurizing dairies.
			Yearly.	Daily.	
	<i>Gallons.</i>		<i>Gallons.</i>	<i>Pints.</i>	
1912.....	11,052,868	569,561	19.4	0.42	6
1913.....	11,535,860	574,577	19.1	.41	19
1914.....	11,548,718	579,593	19.9	.43	28
1915.....	12,467,697	584,609	21.3	.46	33
1916.....	12,780,003	589,621	21.7	.47	43
1917.....	12,564,697	594,637	21.1	.46	41
1918.....	13,718,607	599,657	22.9	.50	45
1919.....	15,490,232	669,981	23.1	.50	52
1920.....	18,335,268	740,172	24.8	.54	55
1921.....	17,792,784	752,865	23.6	.52	53
1922.....	18,792,780	762,222	24.7	.54	46

It is true that about one-quarter of the delivering dairies did go out of business on account of the requirements of Pasteurization, but it is apparent from Table 1 that the net result in no way militated against a steady growth and a healthy competition in the milk industry. Arrangements were effected whereby the small distributing dairies, called "hand dairies," could have their milk Pasteurized for them by certain of the regular Pasteurizing dairies, at a small charge of about five cents per gallon. In fact several Pasteurizing dairies are still catering especially to this business.

PRINCIPLES EMBRACED IN PASTEURIZATION ORDINANCE.

The Baltimore city Pasteurization law defines Pasteurized milk as "milk which has been uniformly heated to a temperature between 142° F., and 150° F., and maintained at that temperature for not less than 30 minutes, and cooled immediately to a temperature of 45° F., or less." Re-Pasteurization of milk is prohibited. It further specifies that "milk or cream while in the plant where it was Pasteurized, or where it is held, kept, or stored, shall be maintained at a temperature below 50° F., and Pasteurized milk or cream shall be maintained at all times, prior to delivery, at a temperature below 60° F."

Pasteurized milk shall not be sold, delivered or offered for sale after 36 hours from the day of Pasteurization.

All apparatus and appliances—shall be thoroughly sterilized immediately prior to every time they are used, and shall be thoroughly cleansed immediately following every use thereof. All bottles and other containers of milk or cream shall have been thoroughly cleansed and sterilized with boiling water or otherwise subjected to a moist heat at a temperature of 200° F., or sterilized by other method approved by the commissioner of health before being filled with milk or cream.

An automatic temperature-recording apparatus shall be installed on Pasteurizing appliances and shall be so maintained that it will accurately record the temperature to which the milk or cream has been raised, and, so far as possible, the duration of time that the milk or cream is maintained at the recorded temperature; and also record the temperature to which Pasteurized milk or cream is cooled.

No person shall sell, or, with intent so to do, have in his possession, care, custody, or control, any Pasteurized milk or cream, unless such milk or cream is contained in and sold in a tightly closed container in which it was Pasteurized or placed immediately after Pasteurization, and then closed and kept continuously closed until after sale. * * * The filling or capping of bottles by hand is prohibited.

Standard milk Pasteurized shall not contain more than 1,500,000 bacteria per cubic centimeter before Pasteurization and shall not contain more than 100,000 bacteria per cubic centimeter after Pasteurization and prior to delivery.

To enforce the above provisions requires an inspection force of five men who constitute the Division of Pasteurization of the Bureau of Chemistry and Food, Baltimore Health Department.

ENFORCEMENT DIFFICULTIES.

The large number of dairies to be supervised and the relatively small number of inspectors available for this work, give some idea of the difficulties of enforcing continuous compliance with the Pasteurization law. If all the dairy men were even cognizant of the

significance of bacterial counts and knew something about heat distribution, the task would not have been so great, but as it was, this Bureau had to start at the bottom and educate the dairymen to a proper appreciation of the above facts. Many dealers would be highly amused when told that a half teaspoonful of their milk contained thousands of bacteria, and wanted to know where the milk could be since so much of the bulk must consist of the bacteria. As a rule, the small dealer is more ignorant of the conditions for the proper handling of milk than the large dealer and needs far more supervision. The performance of small dairies relative to that of the large ones reflects this difference in intelligence. For the year 1922, the bacterial records of all Pasteurizing dairies have been correlated and grouped according to size of dairies as follows:

	Number of dairies.	Weighted average bacteria count per cubic centimeter.
Dairies Pasteurizing less than 1,000 gallons.....	29	27, 100
Dairies Pasteurizing between 1,000 and 10,000 gallons.....	5	20, 400
Dairies Pasteurizing above 10,000 gallons.....	2	7, 800

Together with the higher bacteria count of the relatively numerous small dairies go all the various infractions of the Pasteurization law. The large dealers, always highly intelligent and cooperative with the health department, require but little supervision; the small dealer usually needs as much supervision as the inspection facilities render available.

As is generally well known, the purpose for keeping recording thermometers is to insure compliance with the specifications for heating and holding the milk during Pasteurization. Often the dairymen would shorten the holding time in order to finish up his day's work, or would lower the temperature of holding either to help his cream line or to save coal. The recording thermometer made evident such practice and served to indicate the dairyman's practice in the absence of the inspector. Before long, the unscrupulous dairyman learned that he could manipulate the chart by loosening it from the dial and rotating it under the ink pen. However, a careful examination of such records reveals their fraudulent character, for the reason that dairymen, ignorant and unscrupulous enough to commit such an offense, are also too ignorant to misuse the device skilfully or to understand properly the shape that the recording curves would make. To facilitate the detection of such fraud, the control official should insist that the charts which are made for a given recording thermometer are the ones that are actually used thereon.

Sometimes a capping machine breaks down and the dairyman must finish the capping by hand. At times a capping machine does not seat a cap securely, and the operator completes the process by pushing the cap into place with his finger. Evidences of such practice are the denting or depression of the caps at the center, and the cracking toward the edges.

The law requires that milk utensils must be sterilized. Accordingly, part of an effective control must concern itself with the enforcement of this provision in the handling of milk bottles. Accordingly, the milk bottles of all dairies were regularly examined for cleanliness by making counts of the number of bacteria per bottle. These counts varied within wide limits. So confusing were the results and so enigmatic the causes that the procedure of bottle washing was studied, and made the subject of a special communication to this congress. Briefly, it was found that faulty cleansing and sterilization of milk bottles are caused by the ignorance or carelessness, or both, of milk-plant operators, and that all types of bottle-washing and cleansing machinery now offered to the milk industry will satisfactorily perform if operated according to the instructions of the manufacturer. Knowing, therefore, what the machinery can do, the difficulty of enforcing compliance is greatly lessened. The result is that dealers now are giving as much attention to their bottle-washing equipment as they do to their other machinery, and are not treating this important part of a milk plant as a necessary evil.

The handling of milk cans has been a greatly neglected subject. These necessary vessels have been indifferently washed or not washed at all; left standing around for days at a time; thrown about; kicked off of trains in motion, left to lie overturned on the roadside and in the gutters; licked by farm animals, and allowed to become the feeder of swarms of flies. Many arrests of local dealers were necessary to impress on them this phase of decent milk handling. It is gratifying to note that milk technologists are awake to the importance of cleanliness and sanitation in this respect. Recently several good articles in the literature have clearly shown the character of this menace to low bacteria counts; and machinery dealers and progressive milk dealers have developed methods which are serviceable (though not quite 100 per cent effective) in the cleansing of the cans. Some of these methods have the added advantage of leaving the cans dry after the cleansing process.

The Baltimore milk ordinance requires that the temperature of milk must not rise above 60° F., before delivery to householder. The milk dealers in general endeavor to comply with this requirement, but many do it in a very desultory way. On cool days they make no provision for icing their delivery wagons, assuming that the chill imparted to the milk in the overnight refrigeration will remain until delivery. On warm days a block of ice may be placed on the top of a pile of cases of milk and the melting ice, trickling down over the milk cases, is expected to keep the milk cool. Obviously such cooling is unsatisfactory. Effective cooling by icing is possible only when the ice is broken up into lumps, and distributed uniformly over the cases, and also throughout the pile. To show the effect of strict enforcement of these temperature requirements, reference is made to the following figures which show the average of bacterial counts in certain winter months of 1923:

January	19, 000
February	19, 000
March	22, 000
April	9, 800
May	14, 000

Early in April, the rigid enforcement of the temperature requirements began and the immediate drop in count is significant.

Effective screening of dairies against flies is very difficult to maintain. The rough work pursued and the type of employees play havoc with such delicate equipment as screens. But since infection of milk by flies is always a menace to the public health, it is incumbent upon sanitarians to enforce provision against this menace. Dairymen as a rule are not alert to repair tears in their screens or to keep hinges on their self-closing doors, but our discovery of such negligence always brings a reprimand, and in several cases constituted a charge of revocation of permit to handle milk.

Dealers are slow to realize that Pasteurization does not entirely remedy the fault of handling raw milk in a careless manner.

Some operators have begun the practice of holding raw milk in tanks pending Pasteurization within the next day or so. Even holding milk in refrigerated tanks overnight has been shown to result in greatly increased counts. The result is, milk must be handled promptly or held under better controlled conditions than is provided by refrigerated glass-lined tanks with recording temperature clocks. Low counts in Pasteurized milk can be obtained more easily when the raw milk count is low than when it is high. Moreover, the advantage of a grading system of milk is largely obviated when the bacteria count of milk is controlled only from the production and delivery ends without a parallel control of conditions of holding after receipt at plant and prior to Pasteurization.

Some makes of Pasteurization equipment have been found to be so designed that they do not effectively prevent a slight leak of raw milk into the milk which is being Pasteurized, with the result that some of the milk is not given the requisite holding time, and is therefore unsafe. This has particularly been noted in the faulty seating or otherwise closing of valves which function in a more or less continuous process. A speck of grit is effective, and has frequently been found to cause such a condition. Some manufacturers of equipment operating on the same general principle, obviated this difficulty by slightly rotating the valve during seating, which thus grinds it into its seat. Leaks of water from steam or cooling coils into batches of milk are frequently met with. Soldered joints give way, pin holes rust through, and packing disintegrates and leaks.

Foam on milk is one of the banes in the mechanical handling of milk. It is easy to form and hard to break. The air cushion effectively protects the milk film against the heat of Pasteurization, but the radiated heat supplies an optimum incubating temperature, with the result that enormous numbers of bacteria are thus engendered. Flecks of foam from a filling machine, entrained in the milk entering the bottles, increase enormously the bacteria count. The safest remedy against such inoculations is to preclude the possibility of the milk-level falling so low in the filler that any foam can be sucked in by the vortex at the milk-emptying and bottle-filling port.

RESULTS.

As a result of the enforcement of the milk Pasteurization law in Baltimore, about 98.5 per cent of the milk sold to the public is

Pasteurized. The following table gives the average bacterial counts of Pasteurized milk, by months, for several years since the Pasteurization law went into effect:

Month.	1918	1919	1920	1922
January.....	282,000	56,000	13,000	9,500
February.....	475,000	41,000	8,300	14,000
March.....	450,000	54,000	15,000	16,000
April.....	650,000	52,000	11,000	20,000
May.....	1,500,000	96,000	22,000	18,000
June.....	1,200,000	130,000	21,000	27,000
July.....	1,500,000	120,000	34,000	25,000
August.....	1,700,000	110,000	42,000	21,500
September.....	840,000	120,000	33,000	33,000
October.....	350,000	74,000	22,000	20,000
November.....	115,000	14,000	12,000	16,000
December.....	71,000	27,000	12,000	13,000
Average.....	761,000	74,500	20,400	19,400

In the early days it was comparatively easy to make very large improvements in the counts, but as the dealers became more conversant with the principles of Pasteurization and improved their procedure in accordance therewith, it has become increasingly difficult to reduce the count still further. In fact, it seems that the very much greater effort necessary to attain still lower counts is not warranted by the value of the results. For example, to reduce immediately the average count about 1,000 would require the entire services of at least one extra inspector, whose activities would far better be directed to some other neglected fields, such as ice cream and butter.

Experience in enforcing Pasteurization of milk in Baltimore, and observations of the practice in other cities, have confirmed the conclusion that a municipal health department should not concern itself with the problem of grading milk and dissipate its energies by endeavoring to regulate niceties of classification, but that all the milk should be made reasonably safe and sanitary. The stimulus that price graduations give to improved sanitation and quality in the production and handling of milk should be left to the field of commercial competition. A system such as that developed in Washington, D. C., operates to give a higher price to the farmer when he scores higher, and this stimulates him to seek the inspection service of the health department; the dealer in turn is rated on quality of milk, and his relative standing among the dealers in the city is published. The economic advantage of heading the list is obvious. In the meantime the department of health controls the milk industry in fact as well as in name and does not lay itself open to the embarrassment of purporting to control that which it can only imperfectly do.

Some objection to the Pasteurization of milk is still heard at times, but the public as a whole is consuming more milk than ever before. Since 1912 the average per capita daily consumption of milk in Baltimore rose from 0.42 pint to 0.54 pint, which is rather an effective answer to the objections to Pasteurization on the ground that introduction of this practice will curtail milk consumption.

Thus the experience of Baltimore has shown that good, safe milk can not be obtained merely by passing an ordinance, but that it can

be secured only by cooperating with the dealers and applying educational measures and by the reasonable, yet firm, enforcement of cleanliness and sanitation. The conditions for producing such milk are not highly complicated, but are dependent upon only that which is obvious to the ordinary intelligence, namely, cleanliness to prevent inoculation, heating according to specifications, and prompt and continuous refrigeration.

Chairman ROADHOUSE. Is there any discussion on this paper? If there is nothing more to come before the session, we will stand adjourned.

(Adjournment.)

(Papers read by title) :

THE PRESENT POSITION OF MILK ADMINISTRATION IN SCOTLAND.

GERALD LEIGHTON, M. D., D. Sc., medical officer, Scottish Board of Health; and ARCHIBALD STALKER, public health department, Scottish Board of Health, Edinburgh, Scotland.

Milk administration in Scotland at the present time is in a stage of transition. There has been no alteration in the laws and regulations governing its procedure for a good many years, until 1922, when the milk and dairies (amendment) act was passed by Parliament and became law. A much larger act, the milk and dairies (Scotland) act, which under ordinary circumstances would have become operative in 1914, had to be postponed, first, on account of the Great War itself, and later on account of the stringent economic position which the war has left. It is still on the statute book, but is not likely to be put into operation for some years. The principal effect of the 1922 act was the institution of grades of milk, which are noted later. Now, for the first time in this country, milk is being sold of definitely recognized different qualities designated by law. The grades themselves are much on the same lines in both England and Scotland, the most important difference being that the Scottish Board of Health have insisted that the chemical content of the milk be recognized in grading as well as in its hygienic purity. In the English grades the fat content is disregarded. Speaking generally, the tendency of all Scottish administration also is to place upon the different local authorities the various duties connected with carrying out any regulations such as these, rather than to keep them in the hands of the central Government department.

NOTES IN REGARD TO THE LAW AND REGULATIONS GOVERNING THE SALE OF DAIRY PRODUCE IN SCOTLAND.

Introductory.—The following notes refer principally to milk, which includes skimmed milk, separated milk, and buttermilk. They also refer to cream, butter, and cheese. The principal item, however, is naturally whole milk.

Administrative bodies.—The Scottish Board of Health is the Government department in Scotland charged with responsibility

for seeing that the local administrative bodies carry out their various public health duties. These local bodies are as follows:

1. Town councils, which are composed of members elected for three years. There is no minimum limit to the size of a town, and towns of two and three thousand population are common. There are 202 town councils in Scotland.

2. County councils, which are elected bodies for 33 rural divisions of Scotland, varying in size and importance.

3. District committees of county councils. These are bodies elected for subdivisions of counties, with duties specially allocated to them.

The Board of Agriculture for Scotland is charged with the general duty of promoting the interests of agriculture in Scotland. It undertakes the collection and preparation of statistics relating to agriculture, promotes instruction in that industry, and develops agricultural organization and cooperation in Scotland. The board of health and the board of agriculture constantly confer together on matters of milk administration.

It may be mentioned, however, that the diseases of animals are administered by the Ministry of Agriculture, London, as a United Kingdom matter.

In regard to the sale of milk and other dairy products, town councils and county councils are the administrative authorities for burghal and rural areas, respectively. For the prevention of disease the authorities are town councils and district committees.

Administrative staff.—For the purposes of sampling and analysis of foods, county councils and town councils are required to appoint public analysts, who must be members or associates of the institute of chemists, and must not be engaged in any trade or industry connected with the sale of food or drugs in any area for which they are appointed. Separate officers are appointed for the collection of samples of food and drugs. The town or county council may consider the analyst's certificate with a view to prosecution of offenders, but usually this matter is left to a committee or to a single administrative officer, such as the clerk of the council, the medical officer of health, or the sampling officer.

For health purposes, every county, district, and town council is required to appoint a medical man as medical officer of health; and another officer, called the sanitary inspector, the latter of whom is usually sampling officer as well. Every district and town council in Scotland employs a veterinary surgeon, whose services are available for the examination of cows in the possible event of an outbreak of infectious disease among the community. In the great majority of places these veterinary surgeons are part-time officers, but in the cities of Glasgow and Edinburgh, and in the counties of Lanark, Ayr, and Dumfries, there are whole-time veterinary surgeons, some of whom have a staff of assistants. These counties and cities comprise nearly half of the population of Scotland, and the duties of their veterinary surgeons include regular inspection of dairy cattle.

Control of disease.—1. The public health (Scotland) act, 1897, lays down procedure for the stoppage of milk supplies when infectious disease due to milk breaks out, or is likely to break out. All cases of infectious disease in human beings must be reported to the

medical officer of health of the town or district council; and if such disease occurs at a farm, the act enables the council to issue an order stopping the supply of milk if necessary. Compensation is payable by the council to the producer.

2. In towns there are specific additional powers (which have been exercised rarely) in terms of the Burgh Police (Scotland) act, 1903, for the stoppage of milk supplies, where the council considers that tuberculosis is being caused or is likely to be caused by the milk, including power to secure the stoppage of supplies from areas outside the towns. In this case and also in the preceding case there is provision for an appeal by the producer to a court of law.

3. The dairies, cow sheds, and milk shops, orders of 1885, 1887, and 1899 provide:

(i) That district and town councils shall keep registers of all cow keepers, dairymen, and purveyors of milk in districts and towns.

(ii) That dairies and cow sheds shall be properly lighted and ventilated, cleansed, drained, and supplied with water.

(iii) That a cow keeper, dairyman, or any assistant shall not milk cows, or handle vessels, or in any way take part in the conduct of the business while suffering from a dangerous or infectious disorder, or having recently been in contact with a person so suffering.

(iv) That water-closets, earth closets, privies, cesspools, or urinals are not to be within, or connected directly with, or ventilate into, any dairy or any room used as a milk store or milk shop.

(v) That milk stores and milk shops shall not be used as sleeping apartments, or in any way likely to cause contamination of the milk.

(vi) That swine shall not be kept in a cow shed or milk store.

(vii) That local regulations for dairies, cow sheds, and milk shops may be made by town and district councils.

(viii) That if disease exists among the cattle, the milk of a diseased cow shall not be mixed with other milk, nor sold or used for human food, nor used as food for swine or other animals unless boiled.

4. The milk and dairies (amendment) act, 1922, lays down strong penalties against the sale of milk from cows with tubercular udders: and the burden of exercising reasonable care in the detection of tubercular udders is placed on the producer. This act also provides that, if the public health is endangered by any act or default of a retail purveyor of milk, registration may be refused, or he may be removed from the register.

Sale of milk.—The sale of milk is dealt with administratively under the sale of foods and drugs acts, but there are many provisions in these acts specifically applied to the sale of milk.

When a sample of milk is taken for analysis, the sampling officer is required to declare the purpose for which it is taken, and to divide the sample into three portions, each of which is placed in a separate bottle. One of these is handed to the seller, who may have it analyzed at his own expense; another is submitted to the public analyst; and the third is kept in reserve so that it may be sent to the Government chemist in case of disputed results in court. The standard for milk is contained in the Sale of Milk Regulations, 1901.

and the standard for skimmed or separated milk is contained in the Sale of Milk Regulations (Scotland), 1912. These regulations provide: (1) That if a sample of whole milk contains less than 3 per cent fat or 8.5 per cent solids not fat there shall be a presumption that the milk has been adulterated; and (2) that if a sample of skimmed or separated milk contains less than 8.7 per cent solids not fat a similar presumption shall arise.

The retail purveyor of milk may be protected from legal proceedings on account of deficient samples, if he is in possession of a warranty from the producer, but owing to the facility of adulteration of milk, a warranty is not always given.

In Scotland "test" sampling is common, and about an equal number of "test" and of "formal" samples are taken annually. In the case of "test" samples a messenger purchases milk (or any other article) and it is submitted to analysis without the knowledge of the vendor. No legal proceedings can be based on such a sample, but "test" samples of milk invariably show a higher percentage of adulteration than those taken with the usual legal formalities, and are found useful in administration.

Legal proceedings are usually taken before the sheriff, who is a judge appointed by the government in each district. Sheriffs are always lawyers, and are usually appointed from the higher ranks of the legal profession.

The penalties for adulteration of milk are: Not more than £20 for a first offense; not more than £50 for a second offense; and not more than £100 or imprisonment for a period not exceeding three months for a third or subsequent offense. In Scotland this sentence of imprisonment has never been imposed, and in practice the fines for adulteration have been consistently mitigated, though in exceptional cases the full penalty of £100 has been imposed.

Grading of milk.—The milk and dairies (amendment) act, 1922, authorized the Scottish Board of Health to issue an order setting forth the conditions under which graded milk might be sold, and an order to that effect has been issued.

Four grades of milk are provided for, namely, certified milk, grade A (tuberculin-tested) milk, grade A milk, and Pasteurized milk. The principal points in regard to these grades are that certified milk is milk which is obtained from herds certified to be free from tuberculosis, and which is bottled on the farm; grade A (tuberculin-tested) milk is the same, but consigned by the producer in bulk; grade A milk is milk which has been produced from herds subjected to a clinical examination by a veterinary surgeon at least three times a year; Pasteurized milk refers only to milk which is sold under the designation "Pasteurized." In this case the milk must be held for at least half an hour at a temperature of not less than 145° F. and not more than 150° F., and immediately cooled to not more than 50° F.; 3.5 per cent butterfat is required in connection with each of the first three designations; and the equipment and methods of producers of milk sold under these three designations are to be to the satisfaction of the local authority, on the basis of the score card issued by the Scottish Board of Health.

Standards and sale of other agricultural produce.—There are no standards for cream or buttermilk, and though sampling officers occasionally take samples of these articles, any legal proceedings

based on such samples are seldom successful. There is no standard for cheese.

In regard to butter, the Sale of Butter Regulations, 1902, issued under the sale of food and drugs acts, requires that butter shall contain not more than 16 per cent of moisture. Margarine may not contain more than 10 per cent of butterfat, and every packet of margarine must be labeled conspicuously.

Powers of Government departments.—The Board of Agriculture for Scotland and the Scottish Board of Health have power to procure for analysis samples of any article of food, and in cases where these departments are satisfied that any council has failed to execute or enforce any of the provisions of the sale of food and drugs acts, and that its failure affects the general interest of the consumer, or of agriculturists, as the case may be, they may at the expense of the council concerned take whatever samples are necessary.

In practice, however, the Scottish Board of Health have never exercised this power; nor in regard to dairy products do they undertake any sampling or analysis. In regard to outbreaks of disease that may be due to milk, their medical staff have from time to time carried out inquiries and investigations, but such inquiries have been required only on rare occasions, as infectious disease in Scotland is usually dealt with promptly by the local councils and their officers.

There has been considerable dissatisfaction with the law as it exists in Scotland in regard to the whole matter of the sale of milk. In response to representations by many associations of producers and retailers of milk, an interdepartmental committee was appointed in 1920 to consider the matter, and their report was issued in April, 1922. The committee, of 15 members, included 3 producers of milk, and 3 representatives of the wholesale and retail trades. With one dissentient, they came to the following principal conclusions: That the presumptive standard for milk was unsatisfactory and should give place to a legal standard; that there should be legal standards for skimmed or separated milk, buttermilk, and cream; that local standards for the same articles should be permissible; that there should be regular and frequent sampling of milk; that milk recording should be encouraged; that a first offense against the standard should in all cases be the subject of a warning; that certain means should be adopted to insure that the responsibility for defective samples was placed on the proper individual; and that after four convictions in court it should be within the power of the local authority to withdraw the certificate of registration from any milk vendor.

These recommendations have not yet been embodied in the law.

ADMINISTRATION OF MILK CONTROL.

WILLIAM H. PRICE, M. D., sanitarian. Detroit Creamery Co., Detroit, Mich.

Attempts at milk control must deal squarely with three fundamentals of milk supplies in their relation to human service, namely:

1. Abundant supplies of milk must be maintained.
2. They must be adequately safeguarded.

3. They must be available at reasonable prices, as low as are consistent with maintenance of abundant supplies adequately safeguarded.

Official milk control is attempted for the primary purposes of establishing and maintaining reasonable standards of food value, safety, and cleanliness in milk and milk products, of fostering an abundant supply of milk and stimulating the demand for it, and of creating fair conditions of competition among producers and dealers. Producers and dealers always control the supply factor in any market; consumers always control the demand factor; and, in the final analysis, these economic factors always govern absolutely. To be successful, an attempt at official milk control must recognize these economic factors and harmonize its program with them. There should be no difficulty in so doing.

Administration signifies action, not merely academic discussion of personnel and procedure charts. The first essential of successful administration is a workable program; the second is a competent personnel; the third is concentration on the ultimate goal, with a cutting of red tape and superfluous procedure. One is reminded of the description of an executive:

He was no fool, he knew what he wanted;
He was no coward, he went after it;
He was no trifler, he took the shortest way.

PERSONNEL.

Agricultural college graduates, veterinarians, and others trained in sanitary science presumably take precedence in selection of personnel; but these trainings do not in themselves guarantee industry, integrity, good sense, and rational enthusiasm in the work, all of which are imperative qualities and really determine the success of the effort. Milk control is attempted to secure character in an indispensable product; and character in the administrative personnel is indispensable.

PROGRAM.

Correct conception of prevailing conditions with respect to the local milk supply and knowledge of the relative values of procedures available for milk control are indispensable factors in formulating a program capable of being sustained. Theoretical innovations are interesting for discussion and experimental research, but should not replace proved procedures in actual attempts at milk control. Undue haste should not characterize the framing of the program; insight and reliability are of greater importance than speed. Unnecessary friction with the dairy industry should be avoided. The dairy industry is commonly receptive and cooperative when first approached with reasonable proposals for milk reform, but becomes resentful of extravagant and vacillating policies and antagonized by sensational and discrediting publicity which has no foundation in fact. The interests of harmony and consistent progress when the program is undertaken warrant reasonable expenditure of time in its preparation, thorough survey of the requirements, possibilities and limitations of the particular community, and understanding in

detail of the relative values of the procedures available for milk control.

LEGISLATION.

Official milk control is impossible without a reasonable, practical, and operative ordinance. Excessive legislation may prove a liability to administration. A well-conceived and reasonably executed plan for adequately safeguarding abundant supplies of milk, which are to be sold at prices that will encourage large consumption, is harmonious with the interests of all parties concerned, consumers, health authorities, producers, and dealers; and well-qualified authorities should experience little difficulty in enlisting the support of all parties in the enactment of such a law and in its subsequent enforcement.

Such standards and definitions, together with delegation of authority to the health department to pass rules and regulations for their enforcement, as are necessary for the preservation of food values and of the public health; provision for operation, under the health department, of the revocable license system; and penalty for selling milk without a license or in violation of the ordinance: These provisions are essential in a milk ordinance. The definitions and standards and rules and regulations should be a rational combination of the measures hereinafter discussed. Proper care at this point, to see to it that they are adapted to the possibilities, requirements, and limitations of the particular community, will go far to insure adequate safeguarding without successful opposition from the public or the industry, and will forestall later embarrassment to the enforcing agency.

FRAUD.

Unless officially controlled, fraud almost invariably occurs in competitive milk markets; and, where fraud is occurring, bad milk drives out good milk. The chief asset of the dairy industry is public confidence in the food value and safety of milk, and, obviously, the industry can not progress nor exist on its present extensive basis if public suspicion is directed against those values. Control of fraud by examination of collected samples, prosecutions, and withdrawal of license after repeated violations, is in the interest of the dairy industry as well as of milk consumers.

HOLDING PASTEURIZATION.

Holding Pasteurization is the only adequate safeguard for milk supplies. It destroys all pathogenic organisms that may be contained in milk, and a high percentage of nonpathogens as well, thereby adding 24 hours to the keeping time. It is the obvious answer to the health officer's problem of the incubating, the mild missed, the suppressed, and the carrier types of communicable diseases occurring on dairy farms. Holding Pasteurization does not appreciably affect the physical, chemical, or nutritive qualities of milk. The fact that vitamin C may be affected is of no material consequence, because milk is a relatively poor source of vitamin C, and every milk diet should be supplemented by a readily available antiscorbutic. Holding Pas-

teurization promotes all three of the desirable factors in the milk problem. It assists in maintaining abundant supplies; it adequately safeguards, and it restrains price below what would otherwise be required.

It goes without saying that Pasteurization should be properly done, and, fortunately, it is as easy to Pasteurize properly as otherwise. Heating to a temperature of approximately 145° F., never lower than 142°; holding at that temperature for a period of 30 minutes, then cooling below 50°; invariable recording of temperature and time by a tested thermograph; and protection against subsequent infection by filling into adequately sterilized final containers immediately after Pasteurization and at the place thereof, by machine cappers, by healthy handlers, and in a sanitary environment such as is requisite for the handling of any city milk supply: All these are reasonable and practical requirements and within possibility of supervision and control by any well-qualified health department.

The safety of any city's milk supply is best measured by its proportion of officially supervised Pasteurization. Delay in enforcement of 100 per cent Pasteurization may be advisable in some places in the interest of its ultimate accomplishment, but compromise on the principle of Pasteurization as the only adequate measure for safeguarding milk and milk products is certain to involve the health department in an impossible responsibility.

CITY MILK-PLANT INSPECTION.

Concentration of inspection is distinctly indicated in city milk plants because of the large volumes of milk that they handle and the importance of their Pasteurizing operations, and this is particularly feasible because of their relative fewness in number.

DAIRY-FARM INSPECTION.

In addition to Pasteurization safeguards, cleanliness of production is desired, and the interest of the producer must be enlisted to that end. This can be accomplished only by competent dairy-farm inspection, made systematic by use of the score card of the National Dairy Division and by giving special weight to the essential factors of cooling, sterilizing, small-top pails, and clean cows. Dairy-farm inspection is expensive and is inadequate to insure the safety of large volumes of raw milk. With Pasteurization operative as the main line of defense, much can be accomplished in the way of the essential factors, and of general sanitation and of the prevention of fraud, with a reasonable amount of dairy-farm inspection which it is practicable to employ.

ALTERNATIVES TO PASTEURIZATION.

Scoring, medical inspection, tuberculin testing, low bacterial counts, and grading based on some or all of these are sometimes offered as alternatives for Pasteurization, and a grouping of these procedures on certain farms is sometimes referred to as "ideal production and handling." It is difficult to understand such a philoso-

phy, because none of these procedures, either individually or collectively, offers satisfactory solution of the fundamental problems involved in milk control from the practical standpoint, namely, maintenance of abundant supplies, adequately safeguarded, at minimum prices.

MEDICAL INSPECTION OF MILK HANDLERS.

It is obvious that medical inspection as a means of preventing transmission of infection from dairy farms is impractical, and this conclusion is abundantly proved by the results of such attempts.

TUBERCULIN TESTING.

A considerable propaganda gives bovine tuberculosis infection as a prominent cause of human deaths from tuberculosis, which is contrary to the conclusions of Park and Krumwiede, who present the best, if not the only controlled, studies on this subject in this country. Pasteurization is the quicker and more certain method of preventing the 1 per cent of human deaths from tuberculosis that may be due to bovine infection; and at the same time it prevents transmission of typhoid, diphtheria, scarlet fever, and septic sore throat, against which tuberculin testing offers no protection whatever. The adoption of compulsory tuberculin testing as an essential procedure in milk control detracts attention from other and more important factors and is likely to result in delay or evasion of Pasteurization.

BACTERIAL COUNTS.

When conscientiously made by skilled and experienced workers and intelligently interpreted in their relation to the many factors involved in milk handling, bacterial counts furnish valuable indexes regarding cleanliness of production and handling, age, and cooling of milk, and efficiency of Pasteurizing equipment and methods. Bacterial counts do not safeguard milk nor indicate its safety.

The laboratory is used to check the efficiency of the dairy farm and city milk plant. The question naturally arises. Who checks the laboratory? In common practice the laboratory is seldom checked by outside agencies. When one goes back to original sources for data supporting the bacterial count as a measure of quality in milk supplies, it is astonishing how few are available. When one submits duplicate samples of the same milk to different laboratories, the variety in the bacterial counts reported is astonishing. The bacterial count seems to have been taken for granted by milk administrative officials, and this is doubtless due to widespread propaganda regarding its efficiency as a measure of quality in milk. When applied to the same commodity, a "measure" ought to rate approximately the same in different laboratories; but, as commonly employed, the bacterial count falls short of such a standard. The bacterial count is subject to suspicion because of multiplicity of methods, common and individual sources of error, wide variations, and because of attempts at interpretation by persons without knowledge of the dairy industry.

The potential value of the bacterial count is not doubted; and that value should be made actual by frequent checking and correc-

tion of sources of error. The usefulness of the bacterial count as a measure of quality in milk supplies would be greatly extended by thorough and concerted study by competent and disinterested authorities, to the end that uniform and acceptable standard methods might finally be arrived at, and that permissible limits of variation might be better defined.

GRADING.

Grading is sometimes advocated as a primary factor in milk control. One enthusiast writes: "The foundation stone of efficient control of the milk situation is a system of grading based on dairy scores and bacterial counts;" but, "it is surprising and disappointing to find that only 31 of the 83 cities studied report the use of a grading system, and among these 31 there is little uniformity as to requirements." A national authority writes:

Unfortunately, some cities have passed grading ordinances without having sufficient funds and personnel for proper enforcement. This has resulted in confusion. So-called grade A milk has been sampled and found to be of lower quality than grade B milk. Where such a condition prevails, it would probably be better to have no grading system at all. * * * In spite of the difficulties attending the operation of milk grading, such a system is desirable; but the system must be workable and capably enforced. If poor milk is allowed to masquerade under the title of grade A, the public will be imposed upon, and its confidence in the system shaken. The milk producer, dealer, and consumer will suffer, and the reputation of the health department will not be enviable.

Milk grading does not safeguard, but may impart a false sense of security in raw milk. Many who have had actual experience with milk control believe milk grading which involves more than two grades to be a pretext for avoiding the issue of Pasteurization, for evading the responsibility of adequate safeguarding, and for passing that responsibility back to the consumer.

PUBLICITY.

Reliable publicity which really informs regarding consequential matters is a valuable adjunct in attempts at milk control. But publicity is not administration, and there is danger of reaction from the tumult of voices crying diverse and extravagant propaganda under the motive of "educating the public." A demonstration of accomplishment will prove more satisfying to all concerned.

REVOCABLE LICENSE SYSTEM.

The annual, revocable license system for milk distributors, but not for dairy farmers, who are easily controlled through their city dealers, is the pivot of administration of milk control. No system can observe every day every act concerned with the milk supply of a city. Neither does an occasional fine for violation of laws or rules beget the cooperation that is essential to adequate control. Such cooperation can be secured only when the program is reasonable and its enforcement effective, when the officials are competent, and when milk production and handling are regarded as occupations of character and trust and are controlled and protected as such. The revocable license system lends itself to such a plan. The granting, refusal, and recall of licenses should be based on the record

each dealer makes for himself; i. e., his record of cooperation with the program finally undertaken. It goes without saying that the details of such records, standard food content, Pasteurization, scores, bacterial counts, and reports of communicable diseases, if any, should be recorded in a complete, convincing, and economical way. Such records prove also the reasonableness of the program and the competence of the administration. In such records dairymen and dealers range themselves into the following three classes:

1. Those who know how to produce and handle clean, safe milk, will do so, and will not produce and handle any other kind. There is danger of such dairymen being driven out of the milk business by unfair competition from the dishonest, the ignorant, and the careless. First-class dairymen are performing a distinct and valuable public service and successful milk control requires their protection to the end that they may continue in business.

2. Those who do not know how to produce and handle clean, safe milk, or who have succumbed to the temptation to compete with inferior goods; but who are able and willing to move into the first class and, having done so, make excellent dairymen. It is largely the development of good dairymen out of this class that makes successful milk control an evolutionary proposition.

3. Those who are unable or unwilling to produce and handle only clean, safe milk. It is a large part of milk control to eliminate these third-class dairymen, either into the first class or out of the milk business. Some of this third class are present in every community, but the necessity for summary action against them should be relatively infrequent if handled by competent inspectors, administering a well-conceived and reasonably executed program for milk control in the interest of the public welfare. If allowed to continue in the business, such dairymen establish the milk supply on a low plane by unfair competition with the first two classes. The health administrator can never be certain of cooperation from them. Their elimination is best accomplished by refusal or withdrawal of license, basing such action on their own records. They often decline to be convinced or converted by such records; but they are likely to be vociferous with lip-cooperation, and to offer alternatives for the established program. They regard the milk business as their own exclusive affair, they fight unscrupulously, and they will test the character of the inspector, his competence, and the quality of his program and its manner of execution. Much forbearance is due dairymen during the transition period from an uncontrolled to a controlled milk supply, especially in times when they are in difficulties regarding high costs for feed and labor, and are uncertain of securing and keeping good labor at all. But milk control is defeated if compromise on principles is made with persistent third-class dairymen.

SUMMARY.

Abundant supplies of safe milk must be available at reasonable prices.

An attempt at official milk control must recognize the economic factors involved in the milk problem and harmonize its program with them.

A workable program is administration's first essential; its second is a competent personnel; its third is concentration on the ultimate goal with elimination of superfluous procedure.

A reasonable, practical, and operative ordinance which includes provision for the revocable license system is necessary for success in administration of milk control.

The safety of a city's milk supply is best measured by its proportion of officially controlled pasteurization.

The success of attempts at official milk control is best measured by the control that is obtained over persistently noncooperative dairymen.

SESSION 26. BREEDING METHODS.

Honorary chairman, J. P. DREW, agricultural department, National University, Dublin, Irish Free State.

Chairman, CHARLES L. HILL, Rosendale, Wis.

Secretary, O. E. REED, professor of dairy husbandry, Michigan Agricultural College.

FIRST BAPTIST CHURCH AUDITORIUM,
Syracuse, N. Y., Wednesday, October 10, 1923—9.30 A. M.

Chairman HILL. The hour has arrived for opening this session of the congress. There are many foreign visitors among us this morning, and I am going to ask Prof. J. P. Drew, of the agricultural department, National University, Dublin, Irish Free State, to act as our honorary chairman and take his place on the platform. It gives me great pleasure to introduce the honorary chairman, Professor Drew. [Applause.] The first paper on the program is by Maj. G. J. Buxton, on "Development of the dairy Shorthorn in England and the influence of the breed on English agriculture." [Applause.]

THE DEVELOPMENT OF THE DAIRY SHORTHORN IN ENGLAND AND THE INFLUENCE OF THE BREED ON ENGLISH AGRICULTURE.

Maj. GERARD J. BUXTON, Council of the Dairy Shorthorn Association, Wootton Bassett, England.

It is perhaps appropriate that I, as a member of the Council of the Dairy Shorthorn Association of England, should be here to-day to tell you how the milking Shorthorn has developed in the country and how it has become a part of our English system of agriculture. For, indirectly though it may be, we owe, in some degree, the institution of the association to certain developments in North and South America. Some of you will remember that in the eighties and nineties there was a great demand for Shorthorns in the Western Continent based upon their excellence in meeting the requirements of the farmers in the ranching and beef-producing districts for an animal of rapid fattening propensity, for the production of meat which, in the form of frozen beef, returned to us in England. Bulls of the beef type were almost in greater demand than supply, and prices mounted with extraordinary rapidity, attracting more and more breeders. Everywhere in the Western Hemisphere the inquiry was for bulls of the Cruickshank type—big, thickset animals which invariably crossed well when used on grade or native cattle. And for a time the word Shorthorn became synonymous with rapid beef production. But the early improvers of the breed were as enthusiastic about its milking ability as they were about its fleshing qualities, and the famous Duchess and Daisy types were nearly all first-class milkers, yet possessed of "that union

of qualities of which it is obvious that every breeder of Shorthorns may avail himself who chooses to make the work the object of his care." I quote from one of the early historians of the breed, the Rev. Henry Berry. It was, I believe, from these Duchess and Daisy animals that a number of the earliest importations into the United States were derived a hundred or so years ago.

The exploitation of the vast virgin territories of this continent, indeed, led to such a rapid development of the Shorthorn on the lines of beef alone that the deep-milking qualities of the breed were in danger of being entirely neglected. For some time there had been serious Shorthorn breeders in England who, recognizing the tendency, set themselves to combat it and to remove the menace to milk which the breeding of the short-legged, big-framed animals constituted. By far the greater number of the dairy cattle of England were of the Shorthorn type, but among dairy farmers a strong disinclination had arisen against the use of pedigree bulls because it was thought that the purebred Shorthorns were exclusively beef-producing cattle and would drive away the milk. So that the tendency had already made sufficiently serious progress to justify the measures which were eventually taken to direct the aims of breeders along the right lines of the early pioneers of the breed. A number of the leading breeders, including George Taylor, of Cranford; Robert Hobbs, of Kelmscott; Charles Adeane, of Babraham; and Lord Rothschild founded herds with the idea of restoring milk without interfering with beef. Their common aims brought these men together in 1906, when they instituted the Dairy Shorthorn Association, which, while working in the closest harmony with the Shorthorn Society (Coate's Herd Book) set itself the particular task of encouraging the breeding of the true type of dairy animal. So that is how, indirectly, as I have said, we owe the formation of the Dairy Shorthorn Association, in some degree, to the United States.

The first thing that the association did was to offer prizes at the Royal and the leading county shows for pedigree Shorthorns of good milking type. The qualification for these prizes was conformation, supplemented by adequate actual performance at the pail in the show ring. In 1906 the minimum milk yield to enable a cow to qualify for a prize was:

TABLE 1.—*Early requirements as to milk production for dairy Shorthorns competing in show ring.*

Age of cow.	Having calved within 3 months of first day of show.	Having calved more than 3 months from first day of show.
	Pounds.	Pounds.
4 years and upward.....	25	20
3 years and under 4.....	20	15
Under 3 years.....	15	10

It will be seen that the test was by no means a severe one when we take into consideration the yields of show cows at the present day, but the figures had the effect of encouraging the appearance of Shorthorns of dairy type in the show ring and of directing attention to the fact that the Shorthorn, after all, was a dairy breed. Purebred animals became much more numerous, and at the end of its first year's operations the association numbered 62 members, with Lord Crewe, our present ambassador to France, as its president.

In 1907 the association decided upon the publication of milk records of cows belonging to its members, and was soon able to report that there had been a marked increase in the quantity and the quality of the exhibits at the principal shows. In the first list of records published we find the names of 81 animals, headed by Darlington Cranford, fifth, which gave 12,567 pounds. There were 10 other cows which gave 10,000 pounds or over.

In 1911 rules were established regulating bull competitions for prizes given by the association. A bull was to have descended from a dam and sire's dam that had (a) received certificates of merit in the show ring, or (b) had made a milk record of either 6,000 pounds as a first-calf heifer or 8,000 pounds as a cow.

In 1912 the system of the inspection of the records officially was begun, and during that year 34 herds were periodically inspected. It was in that year that the fuller fruits of the association's efforts became visible. There were now 17 cows with records of 10,000 pounds or over, and there was brisk bidding at all public auctions at which good dairy Shorthorns were offered, 500 guineas being paid for a cow, a very big figure even to-day. Year by year the association saw a steady improvement in both quantity and quality of milk, until in 1916 it was found necessary to raise the standard for the show ring to the following level:

TABLE 2.—*Later requirements as to milk production for dairy Shorthorns competing in show ring.*

Age of cow.	Having calved within 2 months of first day of show.	Having calved between 2 and 3 months before first day of show.	Having calved more than 3 months before first day of show.
	Pounds.	Pounds.	Pounds.
4 years and upward.....	30	27	24
3 years and under 4.....	24	21	18
Under 3 years.....	18	16	12

Milk given by animals of the breed at the Royal in 1916 had a butterfat content of as high as 5.17 per cent. In 1917 we adopted the principle of grading up. There were many beautiful herds in the country of nonpedigree dairy cattle of true Shorthorn type, possessing some of the best and oldest Shorthorn blood, and there was a widespread feeling that the progeny of these cattle should at some date be admitted to Coates's Herd Book, provided that they were sired by purebred bulls. Accordingly, the association established its register of dairy cows of Shorthorn type with authentic

milk records. For the foundation cows the qualification was Shorthorn type and a milk yield of 8,000 pounds of milk in any one year, or not less than 6,500 pounds per annum over an average of two or more consecutive years.

In 1908 our yearbook contained the records of 81 cows and heifers, with a top yield of 12,567 pounds, and there were 11 cows which had given 1,000 gallons, or over. In the yearbook for 1921 there were published 2,497 milk yields, and there were 272 cows recorded that had given 1,000 gallons or over. To-day there are 3 cows that have given 2,000 gallons, and, as you are probably aware, an Australian cow of the dairy Shorthorn breed has produced just under 30,000 pounds of milk and 1,316 pounds of butterfat.

I think that the facts and figures I have given you entitle the Dairy Shorthorn Association to claim not only to have retrieved the milking qualities of the breed from the neglect and obscurity into which they were in danger of falling, but to have improved and extended them while still retaining the great propensity for rapid fattening.

To-day the dairy Southern still forms the great bulk of the dairy cattle of England. It is unofficially estimated that at least 70 per cent of our milking cattle are of the Shorthorn type, and I propose to tell you why, in the opinion of the Dairy Shorthorn Association, this proportion is likely to be raised still further in the immediate future, with great benefit to our milk supplies.

Like the American farmer, the English agriculturist is passing through one of the most disturbing crises in the history of his industry. He has had to face a slump in the prices of the commodities, he has to sell to a level little, if at all, above the pre-war period, while the cost of all that he has to buy in order to carry on his operations is still far above that level. Labor, materials, and, in short, everything that the English farmer needs, whether for the conduct of arable or mixed farming, is at such a high price that many farmers are finding it extremely difficult to continue. For those engaged entirely or mainly in arable farming, in particular, the perplexities are great.

For most of those who have become the owners of their holdings during the last few years, there appears to be only one avenue open if they are to continue at a profit, and that avenue leads to a greater apportionment of farm land to stock raising and dairy farming. Much of the grass land that was put under the plow during the critical years of the war is rapidly going back to pasture in order to bring an immediate reduction in farm costs, and the small farmer is more and more developing that side of his business which is concerned with the local milk market. I do not profess to say that the English farmer will find the change wholly to his immediate benefit, nor that such a change would be good for the nation as a whole, but I do say that in the present condition of our agriculture there is little else for the English farmer to do in the effort to keep going. For the most part, those who have taken up dairy farming have been relieved of many of the anxieties that have troubled their less fortunate brethren engaged almost wholly in the production of cereals. Milk to-day is the only farm produce in regard to which we are free from the competition of other agricultural countries, and our dairy

farmers are adopting the dairy Shorthorn as their stand-by in preference to purely dairy breeds, because they involve less risk of loss of capital. During their milking career these animals give a good output of rich milk on a reasonable ration, and when it is desired to dispose of them they can always be sold at a fair price because they fatten easily and inexpensively and are consequently the subject of a regular demand from the graziers and butchers. There is therefore less depreciation of capital than with the purely dairy breeds, which naturally bring lower prices in a somewhat difficult market when their milking powers have declined. Moreover, while they are in the milking herd these dairy Shorthorn cows are breeding females for the herd and steers for the graziers.

Above all, it is its dual purpose, which the animal so well serves, that makes it so popular. No one claims that it is the ideal animal for the single purpose of the dairy, but it combines so many good points as to make it the ideal dual-utility cow, unsurpassed for the good lands on which the farming is more or less intensive in character. A farmer who obtains an output of around about 750 gallons on an average of milk of about 4 per cent butterfat from the milkers in his herd is handling a profitable proposition, and we are content to set ourselves some such standard and to see that we do not fall below it. We can not afford to concentrate entirely upon milk, though milk is the first item in our program. We aim at the production of good-framed animals with well-hung, capacious bags, and we try to insure, as far as possible, a good market for our stock, its produce, and its progeny at all seasons of the year. Regular breeding of promising stock of the true Shorthorn stamp, of good color, and an output of 700 to 1,000 gallons of milk per annum, are the main desiderata we look for among our cattle. I am glad to say that there is a considerable increase in the number of farmers who are taking up seriously the augmentation of their herd and individual yields by careful breeding, hand in hand with milk recording, and that there is a growing disposition to inquire not only into the immediate ancestry of an animal as regards milk production but into the records of the females for two or three generations back.

The English farmer is no fool, and where his land is suitable for them he generally chooses dairy Shorthorns as likely to yield the most profitable results. We find them admirable for mixed farming, and as I believe you American farmers with your great increasing population are finding mixed farming also a more profitable branch, I feel confident that under suitable conditions the milking Shorthorn will respond well to your needs also. With your elaborate milk-recording arrangements, your energy, and your breeding skill, you will soon equal us in your enthusiasm for the breed and in the confidence in its future when once you have realized its possibilities.

Chairman HILL. Does anyone wish to ask Mr. Buxton any questions?

Mr. C. L. SMITH (agriculturist, Union Pacific system, Portland, Oreg.). I wish to explain to the gentleman from England that the difficulty we have encountered here in America in regard to the

milking Shorthorn is that too many beef Shorthorns have been sold to the general public for milking Shorthorns, and the breed has been discredited. I have been interested in this for 50 years and have myself always been favorably inclined toward the dairy Shorthorn, and I thoroughly indorse what you have said. I believe there is a splendid opportunity for the breeders of purebred milking Shorthorns to build an extensive trade in this country if they will furnish purebred milking Shorthorns. I might say further that I can verify what the gentleman has said about the milking Shorthorns. They are gentle in disposition, and they are not sensitive to weather changes like many dairy breeds that we have here.

Chairman HILL. Is there any further discussion?

Mr. J. O. TRETSVEN (Bozeman, Mont., dairy specialist). I would like to ask Mr. Buxton how those dairy Shorthorns in England differ from our cattle as far as type is concerned.

Major BUXTON. Our difficulty at home is the same as yours here. There have been herds inbred with a beef type very much indeed, and there was a time when the ordinary farmer of England, who kept his Shorthorns, would not buy pedigreed bulls because he realized they were the beef type, and that the produce from these bulls came of a beef type and didn't milk. But we are admitting to the register all those herds that give 800 gallons a year or a little less, over an average of two consecutive years, which, after four crosses, will be eligible for our herd book, so that I venture sometimes to think that the longest pedigree does not in all cases mean best dairy Shorthorn. Perhaps it is so in the beef Shorthorns because you get a dominant type. There is no doubt that in beef Shorthorns the longer your pedigree the more dominant is your strain. The same is true in dairy breeding, with a few exceptions; therefore breeders have turned their attention a little too much to beef and not enough to milk. We are trying to educate them to this. You know in young stock the beef type looks so much more attractive. But that is altered when the young milk stock grows up.

Chairman HILL. The next paper on the program, by Dr. J. F. Tocher, on "Milk yields and associated factors," will be transferred to the end of the program as Doctor Tocher is not present. The next paper is "Measures which have been most effective in raising the production of dairy cows in the United States," by Mr. Helmer Rabild, Grove City Creamery, Grove City, Pa. [Applause.]

MEASURES WHICH HAVE BEEN MOST EFFECTIVE IN RAISING THE PRODUCTION OF DAIRY COWS IN THE UNITED STATES.

HELMER RABILD, manager, Grove City Creamery, Grove City, Pa.

In pioneer days, the few cattle owned by widely scattered settlers pastured on uninclosed land, or browsed in the woods near the clearings. When, in winter, it became necessary to stable them, little was fed except straw and hay. In those days the production of milk during the winter was unthought of on the average farm.

The introduction of the factory system of manufacturing dairy products, the invention of the cream separator, and the adoption of the Babcock test, mark a revolution in the practice of dairying in the United States.

These three great levers are, in the main, responsible for the progress which has taken place in the building of the dairy industry in the United States. An increasing demand for milk became an incentive for all-the-year-around production. The factory system furnished a market the year around, and the cow population began to increase. With the invention of the Babcock test, interest was stimulated in the special-purpose dairy cow.

In 1910 there were approximately 22,000,000 cows kept for milk, on nearly 5,000,000 farms, or an average of 4.5 cows per farm. The average farm cow was usually an animal of mixed breeding, although Shorthorn blood predominated. The average yearly production was 145 pounds of butter per cow. Investigations conducted by *Hoard's Dairyman*, a dairy journal of wide circulation, indicated that more than one-fourth of the herds failed to produce enough milk or butterfat to pay for their feed at market prices.

COW-TESTING ASSOCIATIONS.

Experiments conducted by the various State experiment stations and the Federal Government had brought out many of the factors which have to do with profitable dairy production, the special-purpose dairy cow, proper feeding, breeding, care, and management, but there still remained to devise a workable system, adaptable to the average farm, whereby the productive ability of each cow could be measured, so that the unprofitable cow could be detected and eliminated and the profitable producer perpetuated under proper conditions of feeding and management. The Dairy Division of the United States Department of Agriculture is responsible for perfecting such a system, and, with the assistance of the various colleges, has developed it in 46 States. This system for improving our dairy breeds is the cooperative cow-testing association. The idea was originally borrowed from Denmark, where such organizations had been in operation for some years, but it was necessary to modify the Danish system materially in order to adapt it to our different conditions.

A typical cow-testing association comprises 26 members, owning 400 to 500 cows. The association employs a man skilled in dairying, called the cow tester, who makes a monthly visit to each herd. He weighs and tests the milk from each cow, night and morning, obtains the weight of the feed each animal consumes, and from this data computes the monthly and yearly production. He advises the farmer regarding the feeding, breeding, and management of the herd. Thus, at the end of the year the farmer has a reliable record of each cow's production of milk and butterfat, consumption, and cost of feed, together with the profit made by each cow, and can then make intelligent selection of the cows that should go to the butcher and those that should be retained in the herd, in order to place it on a profitable basis and be used as foundation cows for the future herd.

The cow-testing association has probably done more, directly and indirectly, toward raising the production and placing dairying on a sound business basis than any other single agency. It has eliminated guesswork, which, when applied by the average cow keeper to

his cows, is probably faulty nine times out of ten. It has detected and eliminated thousands of unprofitable cows from our dairy herds. It has saved as many highly profitable dairy cows that were marked for slaughter by the faulty guess of their owners. It has put the management of the dairy herd on a business basis. It has made possible the feeding of cows in accordance with the production, and the development of dairy qualities in cows which, but for this work, would have remained undeveloped. It has largely eliminated the scrub bull from the herds, and has stimulated interest in better breeding, the purebred bull, and the ownership of healthy, purebred herds.

In one year after its organization, an association raised the average butterfat production per cow from 140 pounds, its previous record, to 225 pounds per cow, and in five years had increased the average to 303 pounds. In other words, it has more than doubled its average butterfat production.

The statistics of the cow-testing associations have shown that increased income over cost of feed generally accompanies increased production per cow. A tabulation of more than 21,000 yearly records from various parts of the United States has shown that the cows that produced 100 pounds of butterfat per year had an average income of about \$10 over cost of feed. The cows that produced 200 pounds of butterfat per year had an average income of about \$42 over cost of feed. Those that had an average production of 400 pounds per year had an average income of about \$106 over cost of feed. This means that as butterfat production increased four times, the income over cost of feed increased more than ten times. In other words, one cow of the highest producing group brought the farmer as much income over cost of feed as ten cows of the lowest producing group.

The table below shows the growth of cow-testing associations since the work began in 1906.

TABLE 1.—*Cow-testing associations in the United States, by years.*

Year.	Number of asso- ciations.	Year.	Number of asso- ciations.
1906.....	1	1915.....	211
1907.....	4	1916.....	346
1908.....	6	1917.....	459
1909.....	25	1918.....	353
1910.....	40	1919.....	385
1911.....	64	1920.....	468
1912.....	82	1921.....	452
1913.....	100	1922.....	513
1914.....	163		

These 513 cow-testing associations, in 1922, numbered 12,508 herds, with 216,875 cows. While only about 1 per cent of our dairy cows are tested in cow-testing associations, the influence of the work extends far beyond the boundaries of the associations and penetrates the communities in which the associations are located.

While the average production per cow in the United States is probably not more than 150 pounds of butterfat in a year, the average in cow-testing associations is 250 pounds. Applying these figures to the 216,875 cows which are being tested in cow-testing associations, we find that this increased production amounts to 21,875,000 pounds of butterfat per year, from the same number of cows.

The Dairy Division of the Bureau of Animal Industry has sponsored this work from the beginning, and for a number of years, through its field workers, gave personal assistance in the organization of associations, in cooperation with the State authorities in the various States. The work is now supervised generally by the extension departments of the various State colleges.

BULL ASSOCIATIONS.

Through the work of the cow-testing associations, the members learn the proper feeding and care of the herd and are enabled to cull out the unprofitable or low producing cows, thus raising the average production. The next problem is to maintain this higher average and, if possible, increase it still further. This can only be done by breeding the cows to purebred bulls, that have the ability to produce offspring as good as, or better than, the cows they are bred to. Owing to the high cost of meritorious dairy bulls and the necessity for change of herd bulls every two years to avoid inbreeding, the farmer with a small herd finds it almost impossible to own such a bull alone. The cooperative bull association is designed to bring the use of a good, purebred bull within the purchase power of the smallest dairyman.

The typical cooperative bull association, as organized in this country, is composed of 15 to 30 farmers, and jointly owns five bulls; divides its territory into five breeding blocks, and assigns one bull to each block. As many as 50 or 60 cows may belong to the farmers in each block, and the bull in the block is kept on a farm conveniently located. The blocks are numbered from 1 to 5, and to prevent inbreeding each bull is moved to the next block every two years. If all the bulls live and are kept until each has made one complete circuit, no new bulls need be purchased for 10 years. In this way, by paying only a small part of the purchase price of one bull, each member of the association has the use of good, purebred bulls for many years. Ordinarily the purchase price and the expense of supporting the bulls are apportioned among the members of the association, according to the number of cows owned by each.

The business of the association is handled by a board of directors. They select and buy the bulls, and provide a safe and satisfactory place for keeping them in vigorous breeding condition. The members are associated under rules and regulations which have been carefully worked out under actual conditions and which have been found most suitable to the needs of this particular organization.

The value of a bull for breeding purposes can not be definitely known until his offspring comes in milk. Under individual ownership of bulls in small herds, the bulls can be kept as herd bulls only two years, when they are usually sold to the butcher. Only 13 bulls

out of 376 on New York farms were over 4 years old, according to a recent survey. There were 45 bulls under 9 months, 121 were 1 year old, 117 were 2 years old, and 64 were 3 years old. This means that on three out of four of those farms, the bulls were so young the owners could not tell whether they were good, bad, or indifferent. The real test of value is a comparison of the sire's daughters with their dams, and this is not possible until the daughters come in milk. The bull association offers an opportunity to try bulls and retain the best, reduces losses caused by undesirable bulls, and makes possible the maximum use of prepotent sires.

In Rowan County, N. C., in January, 1918, a cooperative bull association was organized which has made that county famous. The association bought eight well-bred bulls, at an average price of \$360. One of these was at the age when bulls are likely to be sold to the butcher, but this animal's life was saved through his being bought by the Rowan County Association. Records were kept of the production of his daughters, and he, as well as the county, has become famous. This animal was Antoinette's Itchen Rose King. He is regarded as one of the best Guernsey bulls in Dixie.

The bull association is perhaps the most effective method designed in this country for raising the average milk production. It is not like the cow-testing association, limited to herds of 12 cows or over, but is adapted to the small farmer and dairyman, with even as few as 2 to 4 cows. When we remember that the average herd in the United States is only 4.5 cows, we can realize that any method calculated to raise the average production nationally must include the man with the few cows, in order to succeed. The bull association provides the large and small dairy herds with the use of a high-class, purebred bull for a period of 8 to 10 years, at an average cost below that of a cheap bull. With 60 cows in the block, for instance, \$10 per cow would raise \$600 for the purchase of a bull; and in an association of five blocks the farmer has, for a period of 10 years, the use of five \$600 bulls, for the original investment of \$10 per cow.

In nine bull associations in Missouri, the farmer has secured the use of a high-class bull for from 6 to 10 years, at an average initial cost of \$53.40. The average yearly record back of all these bulls is 679 pounds of butter. Would it be possible to conceive any more economical way for the average farmer to breed up a high-producing herd?

When the first bull association in Webster County, Mo., was formed, in 1918, they purchased 6 high-class, purebred bulls. Now they have 15, and the organization is divided into four circuits for exchanging bulls. The association's first 6 bulls replaced 18 scrubs, the total value of the scrubs being \$1,355. The 6 good bulls cost them \$1,657. The average value of each scrub bull was about \$75, and for a comparatively small increase on the cost of all the bulls taken together, purebred sires of an average value of \$276 each, were obtained. In other words, a 22 per cent increase on the investment resulted in having bulls of 266 per cent greater value.

The worth of the purebred sire as an improver of the productive capacity of dairy cows has been measured in a number of localities

where there are both cow-testing and bull associations. In an association at New Windsor, Md., the first daughters of the bulls averaged 70 pounds of butterfat higher than their dams.

If the bulls purchased belong to the same family, an excellent opportunity is offered for line breeding. It encourages community breeding by establishing one breed in the community.

The first dairy bull association was organized in Michigan in 1908, and was followed by two more the same year. In the last few years the interest in bull associations, has become more widely spread, and the United States now has 190 associations in 36 different States. The following table shows the development of the bull associations.

TABLE 2.—*Number of bull associations in the United States, by years.*

Year.	Number of asso- ciations.	Year.	Num ber of asso- ciations.
1908.....	3	1916.....	24
1909.....	8	1917.....	36
1910.....	9	1918.....	44
1911.....	11	1919.....	78
1912.....	11	1920.....	113
1913.....	12	1921.....	158
1914.....	14	1922.....	190
1915.....	15		

The 190 bull associations in 1922 had 6,102 members, 857 bulls, 7,123 purebred cows, and 33,546 grade cows. The average per association was 32 members, 4.5 bulls and 214 cows, of which 38 were purebred. The average member had 7 cows. The average block had 7 members and 48 cows. Of the associations, 86 had purebred Jersey bulls, 68 Holstein-Friesians, 33 Guernseys, 1 Ayrshire, and 2 Short-horns.

The Dairy Division of the Bureau of Animal Industry has been largely responsible for this development. It sent trained men into the field, urged the formation of bull associations, and assisted in their organization. Since the establishment of the county agent system this work is largely done by the county agent, aided by dairy extension men from the State agricultural college.

PRODUCTION RECORDS OF PUREBRED CATTLE.

The spirit of competition has proven a strong lever in raising the production among breeders of purebred dairy cattle. Since 1901, when the American Guernsey Cattle Club, and later the other cattle clubs, established rules and regulations for supervised yearly tests, great progress has been made in the producing capacity of registered purebred dairy cattle. These tests are made under the supervision of the State experiment stations and provide for a daily milk record and a monthly visit of the supervisor, who weighs and tests the milk for a two-day period. It is of interest to compare the production records of the first and last champions of each of the four dairy breeds.

TABLE 3.—*Production records of first and last dairy champions in four standard breeds.*

	First champion.		Latest champion.	
	Milk.	Fat.	Milk.	Fat.
<i>Holstein-Friesian.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
Belle Sarcastic (year 1897).....	23,189.6	727.68	33,464.7	1,349.31
De Kol Plus Segis Dixie.....			137,381.4	1,158.95
Segis Pietertje Prospect.....				
<i>Jersey.</i>				
Dollie's Valentine (year 1899).....	10,218.3	578.7	16,425.0	1,141.28
Darling's Jolly Lassie (4-year-old).....			150,616.0	1,005.9
Fauvic's Star.....				
<i>Guernsey.</i>				
Glenwood Girl 6th.....	12,187.3	572.3	18,626.9	1,103.28
Countess Prue.....			124,008.0	1,098.0
Murne Cowan.....				
<i>Ayrshire.</i>				
Rena Myrtle (year 1896).....	12,172.0	467.9	22,596.0	1,955.56
Lily of Willowmoor.....			125,329.0	894.91
Garclaugh May Mischief.....				

¹ Indicates championship.

This system of measuring, in an authentic way, the production of purebred animals and the recording of the highest production within each breed, has been of incalculable value to the dairy cattle industry. It has stimulated competition among the breeders, set up an ideal, and created inspiration in the man who breeds purebred cattle. It has advertised purebred cattle to the average farmer and made him desire to own a herd of purebreds. Probably of greater importance is the fact that it has furnished a guide for the breeder in selecting the bull for his herd. At present there are about 2,000 registered Guernseys on yearly test, 1,000 Ayrshires, over 2,500 Holstein-Friesians, and between 5,000 and 6,000 Jerseys. Thus the records of more than 10,000 purebred dairy animals are added yearly to the already voluminous record, to aid the man who wishes to select a bull to head his herd.

BOYS' AND GIRLS' DAIRY CLUBS.

The year 1914 marked the beginning of a line of work in the interest of better dairying, which has proven itself of the greatest value and is destined to become increasingly useful. A large percentage of the men who kept dairy cows had had no special training in dairying, and were so occupied with the multitude of duties on the farm that it was difficult to interest them in progressive measures, which would require time and study. The question of keeping the boys on the farm was also much discussed, and ways were sought for that would interest young people in farm life. After very careful study and preliminary investigation, the Dairy Division of the United States Department of Agriculture succeeded in interesting a few communities in what has been called a dairy calf club. It was composed of 10 to 15 boys or girls between the ages of 8 and 15 years, who agreed to feed and care for one heifer calf for one year. In some clubs the banks advanced money for the purchase of the calves and took the note of the boy, with his father's

indorsement. The calves were all purebred and selected from meritorious herds.

The boys and girls took excellent care of the calves, and at the end of the year, when the plan provided for the sale of the calves, a large number of them were bought by farmers whose boys or girls had raised the calves. The good care which the calves had showed in their growth and development, and they grew into fine yearlings.

The next logical step was the "boys' and girls' heifer clubs," and later, the "boys' and girls' dairy cow clubs." The latter are perhaps the most useful, because the boys and girls are often enabled to pay for the cows from the sale of their products before the end of one year.

During 1922, 12,539 farm boys and girls in dairy clubs managed and raised 13,335 dairy animals. The valuation of the animals raised, with the dairy products marketed, totaled approximately \$1,000,000. In the Southern States alone, 6,433 boys and girls managed successfully 6,433 calves, 5,000 of which were purebred and of excellent strain. In the heifer club work, 676 boys and girls fed and cared for 805 dairy heifers, 600 of which were purebred and bred to purebred bulls. The value of the calves dropped totaled approximately \$8,000. In the home dairy work conducted by dairy club girls in the Southern States, 4,859 girls fed and cared for 5,065 family cows, and sold dairy products valued at \$8,547.

These clubs of boys and girls, through their study of the best methods of feeding, care, and management of dairy cattle, have contributed, in a large measure, toward combating the ignorance and inexperience of farmers in relation to their dairy problems. In areas where there was an insufficient number of milk cows to supply the family needs of milk, cream, and butter, the clubs have called attention to the desirability of milk in the diet of children especially, and as a result, a number of dairy cows have been placed on farms which had none before.

In Tennessee, Robert Cooke, a lad of 14 years, is the owner of a Jersey cow that has won the championship of the State, and whose production record was 11,816 pounds of milk, containing 560 pounds of butterfat, in one year. Robert did his own feeding and milking, and weighed the milk every day.

In Nebraska, in 1922, the dairy calf clubs doubled in number and enrollment. They were backed by purebred breeders and by various bankers' associations. In two counties, calves were shipped in from another State and placed on farms where there had never been any dairy animals before. In one county seven clubs were organized, penetrating every community in the county.

The boys' and girls' dairy club work has been exceedingly useful in many communities in stimulating interest in better methods in dairying. It has created among the boys and girls an interest in farming and farm life unknown before. The production of the cows owned by club members has been uniformly high.

ERADICATION OF TUBERCULOSIS.

A discussion of the measures which have been most effective in raising the production of dairy cows would be incomplete without a mention of the accredited herd plan for the eradication of tuber-

culosis from dairy herds. However, inasmuch as the work under this plan undoubtedly has been fully discussed elsewhere, it needs no elaboration here, further than to say that in addition to ridding our herds of infected animals—and a sick cow can not long continue to produce milk profitably—it has started many farmers on the way to improving the production of their herds, by better care, feeding, and breeding.

Chairman HILL. For lack of time, I think we will not ask for discussion of this paper at this time.

The next paper on the program is by Prof. G. C. Humphrey, head of the animal husbandry department, University of Wisconsin, on "Selection of the dairy cow by conformation."

SELECTION OF THE DAIRY COW BY CONFORMATION.

GEO. C. HUMPHREY, chairman, department of animal husbandry, College of Agriculture, University of Wisconsin, Madison, Wis.

Intelligent and painstaking selection is essential and fundamental to successful dairy cattle and milk production. A profitable cow is highly artificial in contrast with the natural and the average female of the bovine race, and haphazard methods of selection do not accomplish successful results in her production. There is also no encouragement under present-day economic conditions to the production of milk without a good foundation on which to establish and maintain a profitable dairy herd. A most rigorous selection at all times is important.

LIMITATIONS IN SELECTION BY CONFORMATION.

Conformation, to which the subject of this article confines our attention, is only one of the indexes of quality and efficiency on the part of a cow. It is generally recognized that there are varying limitations in the accuracy of all methods of selection of the dairy cow, due to her artificial and complex nature. Careful observation, however, will make it clear that the parts of the body which combine to give conformation to the cow have a peculiarity that is common to all cows, and that may be readily recognized. It will also be evident that the peculiarity of the parts of the body of the cow bear a relationship to one another and to her functional activities. The law of correlation, which in the animal body relates to the development or nondevelopment of certain parts at the expense of other parts, explains this relationship and makes it apparent that one who has made careful observation and close study of the cow will naturally rely on conformation to guide him in her selection. The change in the conformation of a cow from the time she is first in milk until she reaches the age of 8 years, when under normal conditions she may be expected to reach her maximum production of milk, will further demonstrate how conformation and the function of the milk organs are correlated.

Dairy conformation and the inherent milk production tendencies in the distinct and improved dairy breeds of cattle have become

pronounced and definite to the extent that they can be observed and recognized to a greater or less degree in young calves and heifers. One does not have to be confined, therefore, to mature cows in the selection of dairy cattle by conformation. The natural laws of inheritance and variation, affecting the presence or absence and the peculiarity of parts and characters of the body, thus attach a high degree of importance to conformation in the selection of cows. A high regard for beauty in cattle, and the desirability of suitable size, age, health, vigor, and disposition, as well as the undesirability of blemishes and abnormal characters, attach further importance to a careful study of conformation in choosing cows for dairy purposes.

The merits of the milk scale and of the butterfat test to indicate the milk-production capacity of cows can not be overlooked and never should be denied. There are no other means to show accurately the milk-production capacity of a cow. A study by Gowen, of the Maine Agricultural Experiment Station, indicated that a milk record, even for only seven days, was approximately two and one-half times as good an indicator of a cow's ability to produce milk as were the physical parts of her conformation. The many experiences of dairymen in cow-testing associations verify the value of records of production in the selection of cows. It is true, nevertheless, that there are a vast number of instances in which dairymen must depend upon conformation in the selection of cows, and it would be fallacy to teach or to believe that success in the organization and maintenance of a dairy herd could be achieved without regard for conformation.

Proficiency in the selection of the cow by conformation is dependent on the powers of observation and judgment, and on one's familiarity with all the parts and characteristics of an ideal dairy cow. It is, furthermore, necessary that the correlation between the parts of the body and the functions of the various body organs be clearly understood. A definition of the more or less significant parts of the dairy cow and the correlation between such parts and her chief characteristics and body functions will be attempted.

DAIRY VERSUS BEEF CONFORMATION.

The contrast between animals carefully selected and highly efficient in the production of milk and of beef, respectively, is the most striking example of the differences in the parts which combine to give conformation to cattle and of the correlation between conformation and function. The distinction between the highly fed beef animal and the equally well-managed dairy animal forms a good basis for the study of selection by conformation. The highly fed beef animal, with a natural tendency to become thickly fleshed in the region of the back, loin, and thighs, and with a corresponding thickness and fullness of flesh in the neck, over the withers and shoulders, and about the brisket, in contrast with the highly developed dairy animal, with its angular, thinly fleshed body, and highly developed milk organs, reveals the fact that conformation is indicative of beef qualities, on the one hand, and dairy qualities, on the other.

It is unfortunate that the art of selection, breeding, feeding, and management of cattle has not yet reached a stage of development where uniformity of conformation and of production ability characterize the majority of herds. The work and accomplishments of

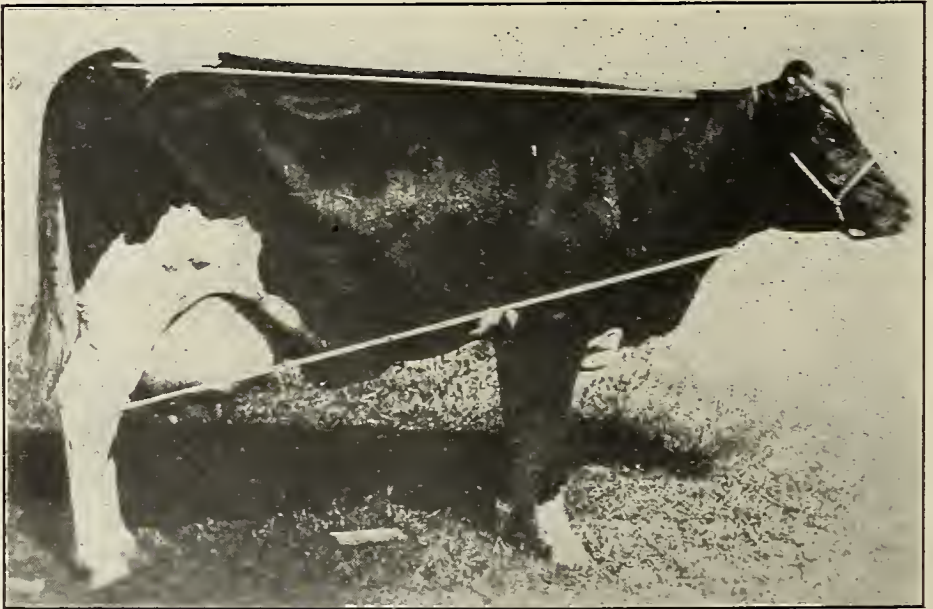
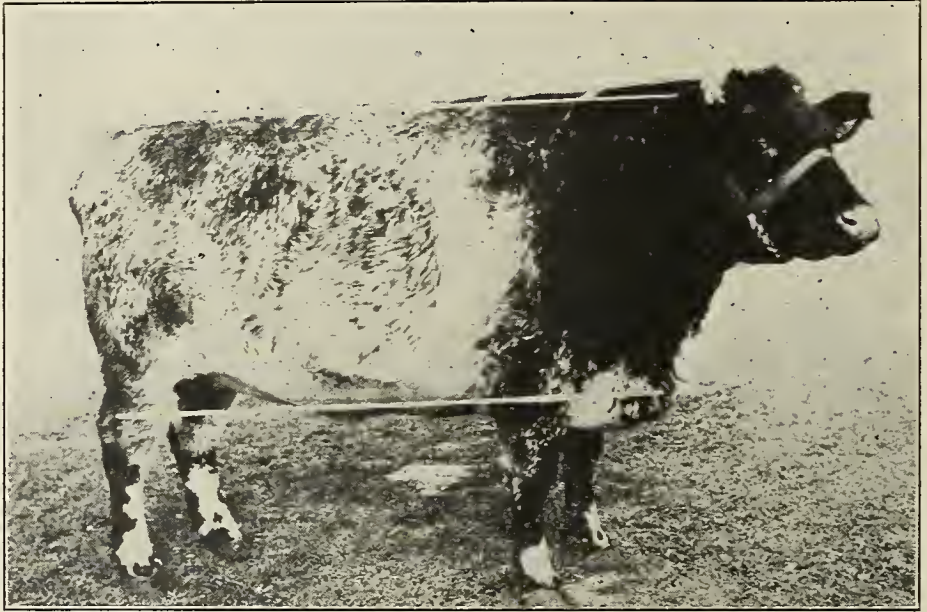


FIG. 1.—The difference between beef and dairy types. The beef animal has straight top and bottom lines, while the dairy cow is wedge shaped.

painstaking men in the production and perfection of herds within given breeds indicates that a remarkable degree of uniformity in both conformation and production ability can be attained. This fact offers great encouragement in the fuller development of herds that can be relied upon for most satisfactory results. In the case of

underfed, poorly developed cattle, conformation is of little value in the determination of their merit, and under such conditions one is naturally obliged to resort to pedigrees, records of production, and speculation of judgment in order to give credit for any degree of efficiency.

DAIRY CONFORMATION DEFINED.

True representative animals of the dairy breeds are quite similar to one another in conformation. This conformation is commonly

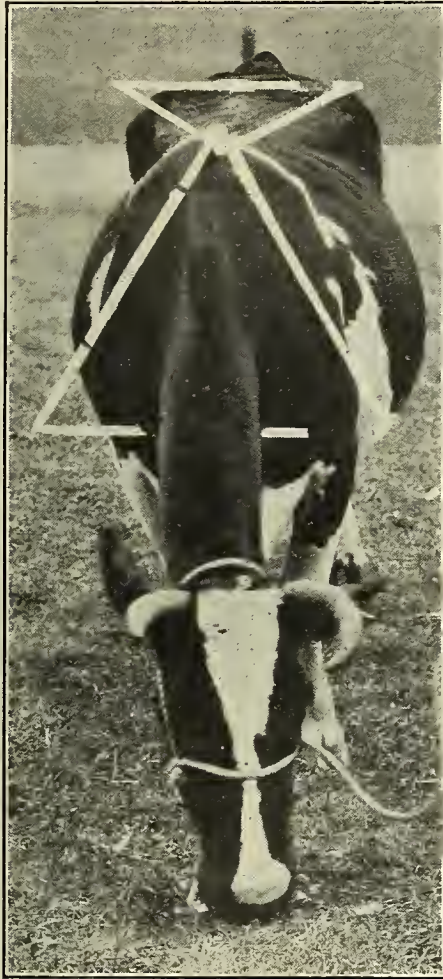


FIG. 2.—Look for the wedges. The body should be wedge shaped when viewed from the front and top of the withers, wider at the hip bones and at the floor of the chest than at the point of the withers.

termed “dairy form,” or “dairy type.” Its outstanding features are: An angular form, due to a comparatively thin development of flesh over all parts of the body; a more or less distended condition of the abdominal part of the body, commonly called the barrel; and a large development of the udder or milk organs.

The dairy cow is frequently described as triangular or wedge-shaped in form. This form is quite characteristic of all good dairy cows, and may be readily recognized. A view of the side presents one triangular outline of the body, which is formed by the top and bottom lines converging as they extend forward. (Fig. 1.) The



FIG. 3.—Beef animals blocky; dairy cattle angular. Fullness of the fore and hind quarters are typical of the beef animals. A comparatively long head, sharp brisket, and pronounced udder development characterize the dairy cow.

bottom line in this instance should extend from the bottom side of the udder to the throat, and will not run parallel with all of the underline of the body. This wedge-shaped view of the body is less distinct in many respects than the other two wedge-like appearances which may be noted.

A line between the hip points and lines from these points to the point of the withers or top of the shoulders, produces a triangle indicative of the form of this part of the body. Some cows tend to be heavier over the top of the shoulders than others. The width of the body at the withers in dairy cows of true form is always much less than it is in beef animals of true form.

Lines extending down over the shoulders at each side of the body from the top of the withers to a line joining the points of the shoulders form a third triangle and indicate the wedge shape of the body in the fore quarters.

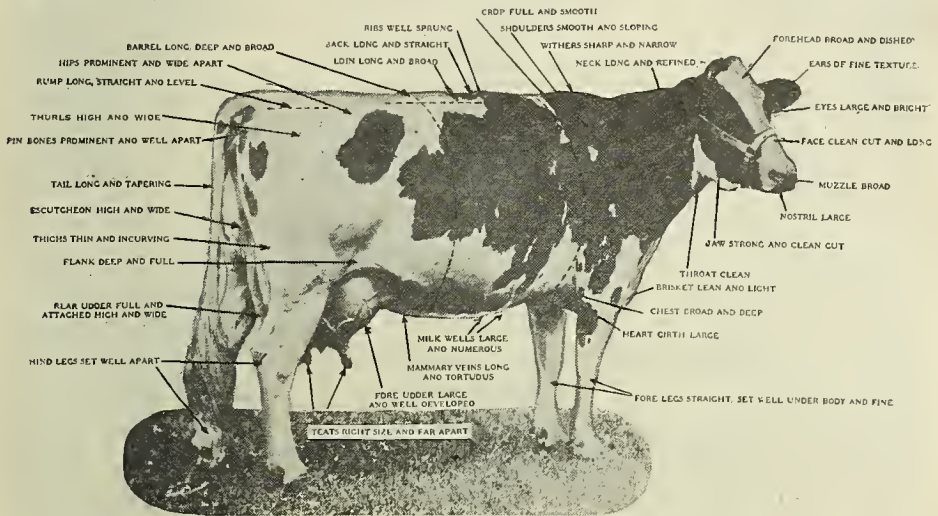


FIG. 4.—The parts of a dairy cow. A dairy cow should have large capacity for feed, a dairy temperament, well-developed milk organs, fine quality, and perfect health, and be capable of a large production of milk and butterfat. Duchess Skylark Ormsby, a former champion cow for yearly butterfat production, record 27,761.7 pounds of milk, 1,205.09 pounds of butterfat, shows excellence in all parts.

These three triangular outlines of the body of the dairy cow, which one may see from the side, the rear, and the top, are a contrast to the rectangular outline that will be readily recognized in all well-developed beef animals.

Dairy conformation is further defined by additional features which one may observe in logical order by a close scrutiny of the head and the respective adjoining parts. The head of the dairy cow is comparatively lean and clear-cut in all parts, and relatively longer than the head which characterizes a good beef animal. The forehead is dished, the eyes prominent and full of expression, the muzzle wide, with strong lips and open nostrils, and the jaws lean and sinewy.

The neck of the dairy cow is comparatively thin and long, neat at its juncture with the head, straight at the top and nicely blended with the shoulders, which are comparatively lean, nicely laid up to the body, rather sharp at the withers, and prominent at the lower point. The under side of the neck should preferably be without too much dewlap, and the brisket should be lean and sharp, or V-

shaped rather than round and full as it ordinarily appears in a beef animal.

A straight back with a broad open chine, a broad level loin, and hips and thurls that are wide apart and high, characterize the most desirable cow. A long, wide, level rump, and thighs that are wide apart, thin and incurving, with an abundance of room for the development of the udder, are desirable features. The barrel or portion of the body between the fore and hind quarters should be long, deep, and roomy. Ribs that are long, far apart, and well sprung, together with fore and rear flanks that are deep and comparatively full, give

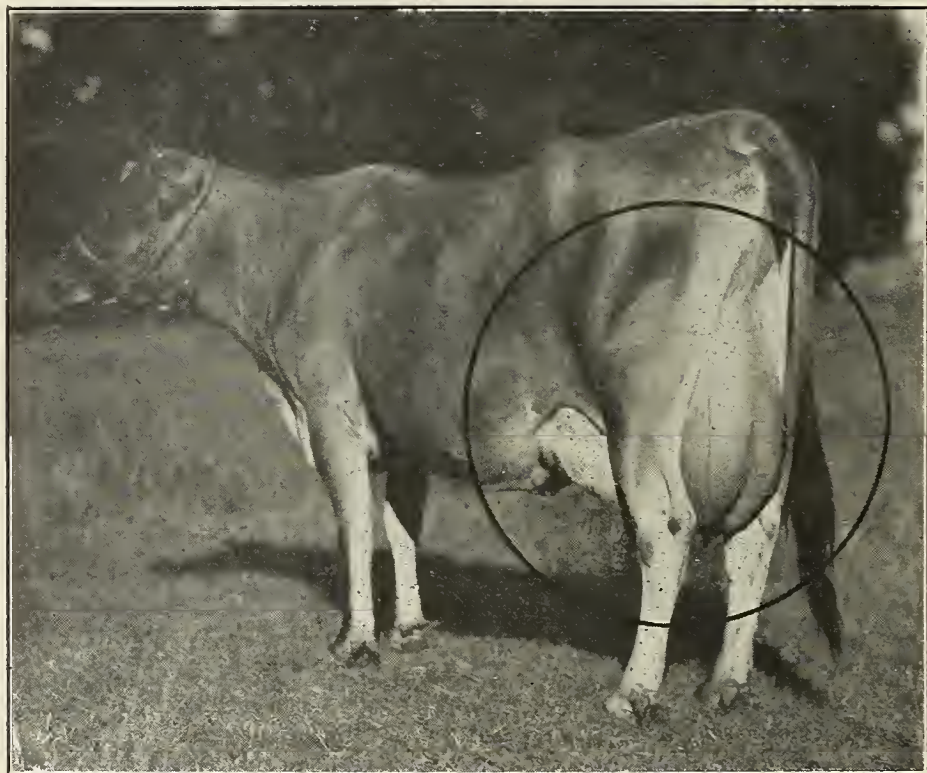


FIG. 5.—Type of good udder. The udder should be large, well proportioned, balanced, extended far forward, and high up between the thighs. It should be of fine texture and pliable, and the skin should stretch readily when the udder has been milked out.

depth, length, and width to the body and a desirable capacity for feed consumption.

THE MILK ORGANS.

A large, pliable udder, equally well developed in all of the quarters and extending well forward on the body and high up behind and between the thighs, is a prominent and important feature of the dairy cow. Udders will bear a most careful study. Good size and quality are most important considerations. A refined, plastic condition of the udder tissues and a freedom from hardness, which may be due to injury or to fat and flesh other than gland tissue, should be in evidence. Udders which are poorly attached to the body and which have

a tendency to swing or become pendulous are most subject to injury and may be regarded undesirable. Large udders, with uniformly well-developed quarters, of good quality, with good attachment to the body and with teats of convenient and uniform size are most ideal.

Incident to a study of the udder, one will naturally observe the mammary veins, commonly called milk veins, which extend from the udder to one or more wells at each side of the body. The wells refer to openings through the wall of the body which permit the veins to follow a course that leads to the heart. The development of veins over the udder is regarded as a good feature. Considerable variation will be noted in the development and presence of veins, not only on the under side of the body and over the udder, but also on the face of the head. A coat of fine hair, a pliable, superabundance of skin, and oily secretions more especially noticeable in the ears and at the end of the tail, are features which may be associated with a strong circulation of blood to all parts of the body, and indicative of a desirable activity on the part of the glands of the udder.

The matter of escutcheon, which is outlined by a mark made by the difference in the direction in which the hair runs at the rear of the thighs and above the udder, is discussed more or less by dairy-men. Guenon, a French student of the dairy cow, associated the escutcheon with the arteries that carry blood to the udder and attached considerable importance to it. American investigators who have studied types of escutcheons in their relationship with actual production of milk and butterfat have not thus far been able to attach any importance to it. American judges have given little attention to the matter of escutcheon. Well-outlined escutcheons that are wide and extend high, combined with thigh ovals, are usually considered most desirable. The thigh ovals refer to a peculiar condition and patch-like appearance of the hair noted at the back side of the udder of some cows and entirely absent on the udders of many cows.

MARKS OF DAIRY TEMPERAMENT.

The expression "dairy temperament" has been used to name one of the dairy characteristics of a cow, and in view of the common use of the term it may be acceptable to describe the peculiar inherent characteristic of the dairy cow which enables her to convert feed into milk rather than into flesh. Dairy cattle have acquired this characteristic ability through long processes of selection and by breeding for milk and butterfat production. The ability to convert feed into milk rather than into flesh varies in strength even among purebred dairy animals, and it may be regarded as one of the hardest things to judge satisfactorily in consideration of dairy conformation. Only cows with a highly developed dairy temperament, in combination with other characteristics relating to capacity for feed, large, well-developed udders, and a vigorous constitution, are capable of large and economical production of milk and butterfat. Cows excelling in dairy temperament show the following characteristics:

Head and face clean-cut in outline and indicative of fine quality. Eyes prominent, bright, and active. Neck fine, clean-cut, neatly joined to the head, not too full at the throat, and comparatively long

and thin. Shoulders oblique, comparatively bare of flesh, sharp at the withers. Hips and pin bones prominent and comparatively sharp. Ribs more or less prominent and open. Chine prominent and open. Thighs thin and incurving. Bone fine rather than coarse in all parts of the body, indicating desirable quality. Hide and hair fine and soft to the touch of the hand, with oily secretions.

The lean, comparatively undeveloped muscular tissue over the body of the dairy cow, more especially on the outside and under side of the shoulder blades, along the back and in the thighs, is due to dairy temperament. The wedge-shaped conformation of the fore quarters and the top of the back is due to the absence of flesh about the neck and the fore quarters. It may be said, therefore, that the



FIG. 6.—A cow with marked dairy temperament. Clean-cut features about the head and face, the fine, clean neck, the prominence and sharpness of the backbone, hip points, and pin bones, the thin, incurving thighs, and the clean, fine shanks in this cow are indications of extreme dairy temperament.

sharp ends of the triple wedge-shaped conformation are indicative of dairy temperament.

In judging dairy temperament the quality and condition of the muscular tissue of the body must be taken into consideration and an allowance made for the size, age, and stage of lactation of the cow in question. The fact that the bone and muscular tissues in a large cow are naturally heavier than in a smaller one must be borne in mind. There is not the natural refinement and spareness of form in the larger breeds of dairy cattle that there is in the smaller ones. Marked coarseness, however, in any animal is undesirable. It is usually accompanied by a sluggish disposition and inactivity that prevents the dairy cow performing satisfactorily at the pail. Young heifers with their first calves and highly fitted cows in the early stage of lactation usually carry more flesh than cows of mature form and in the advanced stage of lactation. These are facts to be considered in exercising judgment on dairy temperament.

INDICATIONS OF A VIGOROUS CONSTITUTION.

A healthy, vigorous constitution is the mainspring of all activity on the part of the dairy cow. The period of usefulness of a cow depends much upon a rational system of feeding and management. There is a great difference, however, with reference to how cows withstand the strain of milk production and the production of offspring from year to year, and the natural strength and enduring qualities of cows appear to be largely due to their constitution. There is much evidence to indicate that under normal conditions and with the right kind of health and vigor a cow will gradually increase in her rate of production to the age of 8 years, and continue to be more or less profitable for a varying number of years thereafter. As a matter of fact, however, cows, for one reason or another, have a comparatively short lifetime of actual service, which, it appears, might be considerably extended if more attention were given to the matter of health and vigorous constitution.

Size in accordance with the breed, combined with apparent strength and vigorous activity, without undue refinement or coarseness, and with every indication of a healthy circulation of blood to all parts of the body, may be regarded as indications of good working ability over an extended period of time. When a cow is sick or physically weak she will naturally appear dull and sluggish. There will be a dry, hard condition of the skin, and her coat of hair will be staring. Digestion will be impaired and the milk organs will fail to function properly, and a low production of milk will naturally follow.

Large, open nostrils, providing ample air passages to the lungs, and a good heart girth of the body, indicating a roomy chest cavity for the heart and lungs, are desirable features in judging constitution. This is apparent from the significance that is naturally attached to the function of the most vital organs. A narrow head, pointed nose, contracted listless eye, and narrow, shallow body are indications of poor constitution and low vitality. The presence of well-developed veins on the under side of the body, over the udder, and on the face, together with a pliable, oily condition of the skin and a soft, healthy condition of the hair, are further evidences of health and vigor.

QUALITY, SYMMETRY, AND BEAUTY OF CONFORMATION.

Fineness of bone, hair, hide, and horn, in contrast with coarseness of these features, is an indication of desirable quality. The head, neck, shoulders, hip points, tail, and bones of the legs, with reference to indication of fineness or coarseness, offers opportunity for judging general quality. The hand is employed to judge the texture of the hide and hair. Undue refinement or marked coarseness are not characteristic of the best representative dairy animals. Fineness and smoothness in the parts of the body, combined with good size and a healthy appearance of the animal, are marks of quality common to the best cows.

Symmetry of form relates to a full development of all parts, bearing a proper relationship to one another, proportionate to the size of the cow, and blended in a manner to give due balance and

beauty of conformation. Symmetry of form, when combined with true breed characteristics, including color, size, character of horn, and good condition of body, produces a pleasing effect. It is, therefore, worth while to lay emphasis upon a neat, clean appearance of the head; a straight top line, including the back and rump; a neck set on a level with the back, and free from throatiness and unnecessary dewlap; shoulders that blend nicely with the body and that are not too heavy or prominent over the top; and legs that are comparatively straight and well-placed under the body, with feet that stand firmly and give good support to the cow. These features have an intrinsic and monetary value and are, therefore, worth while to consider in the production of dairy cattle, even though there may be no correlation between them and milk production.

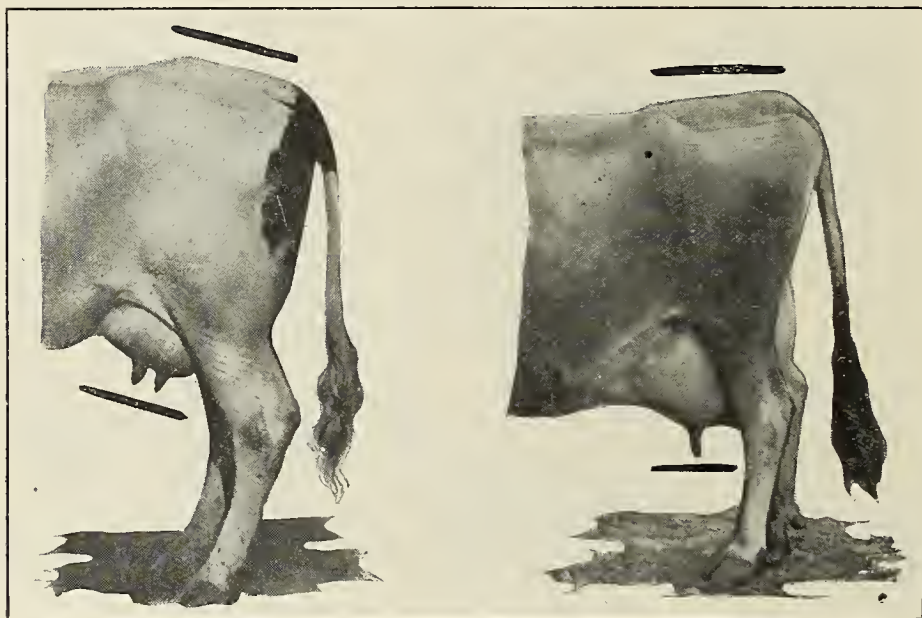


FIG. 7.—Two types of rumps. Rumps that droop and are low at the pin bones detract from the beauty of the cow and are usually accompanied by udders which tilt forward.

DEFICIENCIES WHICH DISCREDIT THE COW.

Show-ring judges and buyers of dairy cattle will naturally discredit a cow which is noticeably deficient in the following respects:

Head lacking width and dish of forehead, too long or too short, narrow at the muzzle, coarse in appearance, with an eye too small or lacking alertness of expression.

Neck too short, and beefy, carrying too much dewlap and fullness at the throat, and that is poorly set with reference to juncture with head and shoulders.

Body too short, lacking in depth and weak in the back.

Hind quarters short, narrow, or drooping, with thighs too thickly fleshed.

Udder unbalanced and irregular in shape, poorly attached, with teats too short, irregular in size, or improperly placed.

Legs crooked, too short or too long, set too close or too far apart, and out of proportion to the rest of the body in size and bone.
Tail set too far forward, too heavy in bone, and too short.

THE SIGNIFICANCE OF DAIRY CONFORMATION.

There must be a significance attached to dairy conformation and the correlation established between it and production before one can have faith in the selection of the cow by conformation. To understand the significance of conformation and its relationship to milk production, one must first thoroughly understand what may be termed "dairy characteristics." These characteristics apply to cows, and more or less to bulls, of the dairy breeds, and are: Feed capacity, dairy temperament, vigorous constitution, and well-developed milk organs. These four characteristics are essential to a large and profitable production of milk and butterfat over the period of years constituting the normal lifetime of a cow.

A dairy cow usually fails in the production of milk and in commanding the highest price that may be paid for her, to the extent that she is lacking in one or more of these essential characteristics. Each part of the body heretofore named and described bears some relation to one or more of the so-called dairy characteristics. Some exception may be made to the features which relate to symmetry and beauty of form and which have no other value than to please the eye of the owner or purchaser. One is not likely to err seriously in his judgment in the selection of the cow by conformation when he considers all parts of the body in their relationship to each of the four dairy characteristics that have been named.

FEED CAPACITY FUNDAMENTAL.

Feed is the source of milk, and the consumption of a large amount of feed on the part of the cow is highly essential. A large body, more especially the barrel, in proportion to the size of the animal, indicates feed capacity. The base ends of the three wedge-like outlines of the body of the cow bear a relationship to, and are good indications of, feed capacity. The deeper the cow is at the rear parts of her barrel, the wider she is between the hip points, and the greater the width at the points of the shoulders the greater will be her capacity for feed. Ribs that are well sprung and far apart, a chine that is open, and a back that is wide over the loins, and a depression between the last rib and the hip point that is large, are all evidences of good feed capacity. A correlation may be established between the width of the forehead and the width of the body; between a comparatively long face and a good length of body; and between a broad muzzle, good-sized mouth, and long sinewy jaws, and a good feeder. These parts may therefore be associated with feed capacity.

DAIRY TEMPERAMENT NECESSARY.

It is reasonable to understand that a dairy cow which has been developed by generations of careful selection and breeding to produce milk in large quantities throughout long lactation periods and over a long period of years constituting her normal lifetime of use-

fulness, can not be expected to produce large quantities of both milk and beef. It is natural for dairy cows to have a comparatively thin covering of flesh over the body and to be angular and wedge-like in conformation. The sharp ends of the wedge-like outlines of the body heretofore mentioned are evidences of dairy temperament. This is true, however, only in the case of cows which are well fed and in a healthy condition. An emaciated cow of any of the beef breeds would approach some dairy cows in conformation as regards the thin condition of flesh over the body. It is, therefore, necessary to judge dairy temperament in combination with as much information on the health and the conditions under which the cow has been maintained as can be secured. It should, furthermore, be closely associated with the characteristics denoting feed capacity and well-developed milk organs. Cows are very likely to be a disappointment in milk production when there are no evidences of dairy temperament. Marked dairy temperament, however, will not compensate for deficiencies in feed capacity and milk organs.

WELL-DEVELOPED MILK ORGANS HIGHLY ESSENTIAL.

The udder is the milk-secreting organ, and its proper development is therefore essential. Associated with the udder are the mammary veins, which indicate in a large measure the manner in which the glands of the udder are supported by a strong circulation of the blood. Size, quality, and a healthy condition of the udder are most important considerations in correlating this characteristic of dairy confirmation with large production of milk.

The udder consists of two large glands, more or less distinctly divided to correspond to each of the four teats. A duct from each teat enters a small cavity termed the milk reservoir. The milk reservoir of each quarter is more or less surrounded by lobes of glands held closely in position by connecting tissue. These lobes resemble bunches of grapes. Each lobe has several divisions called lobules, corresponding to the grapes. The lobules are made up of small divisions called alveoli, which correspond to the seeds of the grapes. These alveoli are again made up of small cells surrounded by fine networks of blood vessels and nerves. Milk is secreted by these cells. It is believed that the more tortuous and branching the milk veins are, and the more extension the milk veins have as indicated by their character on the under side of the body, the greater will be the capacity of the cells of the udder in the secretion of milk.

The correlation between well-developed udders and mammary veins and milk production has been demonstrated more frequently than has the correlation between other parts of the conformation and a satisfactory production of milk. It is for this reason that well-developed milk organs, and a careful consideration of them, are highly essential to success in the selection of the dairy cow by conformation.

HEALTH AND VIGOR AN ABSOLUTE NECESSITY.

It is unreasonable to expect that any animal can perform its work satisfactorily when its health, strength, and vitality are more or less impaired. There should be every indication of full vigor

and perfect health on the part of any cow selected for milk-production purposes. This is important, not only from the standpoint of large and profitable production of milk and butterfat, but from the standpoint of these products being suitable for human consumption. However perfect an animal may be in size of body and milk organs, there can be no production without the forces indicated by vigor and perfect health.

JUDGING AS AN ART.

Judging dairy cattle, in its relationship to the successful operation of a dairy farm, may be regarded as a useful art. The careful dairyman will find it advantageous to study carefully the art of judging by conformation. "Beauty is bought by judgment of the eye." A keen eye is needed for all successful livestock enterprises. Show-yard exhibitions may not necessarily include dairy cattle of the greatest production ability. There appears to be no reason, however, why show-yard animals can not be a combination of beauty, choice breeding, and high productive capacity. Such animals are becoming more common; and the show-yard judge who, in consideration of the prize-winning animals, can combine productive capacity with beauty of outline is most appreciated.

The selection of profitable dairy cows by conformation is an art that does not necessarily have to take into consideration all of the dairy show-ring standards, and it is believed that the practical dairyman can in a large measure judge the merits of the dairy cow by conformation when he has learned to correlate her essential features and characteristics as heretofore discussed, and which may be observed in most successful herds as well as in show-yard exhibitions. In support of all that has been said with reference to the conformation of cows, it is gratifying to know that the best dairy men of the country are keen in their powers of observation, and possess cows which conform in a large measure to the conformation which this article has attempted to describe. Such conformation may well serve as the sole guide in the selection of cows under many circumstances, and under all conditions will prove valuable in herd development.

Chairman HILL. The next paper is "The problem of breeding for milk production," by R. R. Graves, specialist in dairy cattle breeding, United States Department of Agriculture. [Applause.]

THE PROBLEM OF BREEDING FOR MILK PRODUCTION.

ROY RALPH GRAVES, specialist in dairy cattle breeding, Dairy Division, United States Department of Agriculture.

The problem facing the breeders of our modern dairy cattle is how to breed so that a high level of production of milk and butterfat, say, an average of 600 pounds of fat and the equivalent milk production for the various breeds, will be transmitted with as much uniformity and surety as the breeds now transmit breed characteristics.

When we mate purebred Holstein-Friesians we expect that the offspring will have the characteristics of the breed in color, size, shape, per cent butterfat, and so on. It is only rarely that we are

disappointed—sometimes in color, sometimes in size, or some other feature—but usually the breed characteristics have been so fixed that they breed true. Of course there is variation within the breeds. The color of the Holstein-Friesians varies from almost all white to a predominating black; yet a purebred Holstein without some black on the body (except it be a red and white purebred), or one without some white below the knees and hocks, is almost never found. All of our breeds have their variable features, but it is not often that a Holstein-Friesian will be mistaken for a Jersey, or an Ayshire for a Brown Swiss.

All breeders are seeking to breed level top lines, broad level rumps, udders that are well balanced and well attached front and rear, teats of good size and well placed, barrels that are of good length and depth, with well-sprung ribs. These points are being fixed so that they are transmitted with considerable regularity. In some of the breeds these points in conformation seem to be transmitted with less variation than in others, indicating that these particular breeds are reaching the point where the factors controlling the conformation of the various parts of the body are pure for the desired type.

With the producing capacity, however, we do not appear to have attained the uniformity that has been secured with other breed characteristics and type. An illustration of the great variation that takes place in the producing capacity of our purebred dairy cattle may be found in the records of the tested daughters of almost any sire. Recently we studied the transmitting ability of 23 Holstein-Friesian sires that had six or more yearly-record daughters, each of which was from a dam with a yearly record. We are continuing this work with the sires of the other dairy cattle breeds. The average range in milk production between the lowest and highest producing daughters of these 23 sires was almost 9,000 pounds, while the average range in milk production of the dams of the daughters of these 23 sires was a little over 8,000 pounds. One of these sires had 20 daughters, and there was a difference of 18,000 pounds of milk between the record of his highest and his lowest producing daughter, with the production of the other daughters spread out very evenly between these two extremes. Between the lowest record and the highest record dam of these same daughters the spread was 19,000 pounds. There was a difference of less than 5,000 pounds of milk between the highest and lowest producing daughters of two of the sires studied. There was a spread of 4,000 pounds between the highest and lowest record daughter of one of these sires and a spread of only 2,000 pounds between the lowest and highest record daughter of the other sire. Five of the seven daughters of the latter produced less than their dams. Often the producing capacity of full sisters varies greatly, a difference of 4,000 to 6,000 pounds of milk between the records of full sisters is not uncommon, and a difference as great as 10,000 pounds of milk has been noted.

An example of the uncertainty of the purebred in transmitting production occurred in the experiment of grading up from common dams of Shorthorn and Hereford ancestry, reported by the South Dakota Experiment Station. The three-grade foundation cows used had an average production of 3,759 pounds of milk and 155.9 pounds butterfat. One Holstein bull has five daughters out of these three

cows and the average production of these daughters was 7,152 pounds milk and 259 pounds butterfat. This is an increase in the daughters of 100 per cent in milk and 79 per cent in butterfat. The second bull used on the daughters of the first bull got two daughters that made an average production of 10,289 pounds milk, 258 pounds butterfat. This represents an increase over their dams of 44 per cent in milk and 26 per cent in butterfat. The third bull used had only one daughter reported with a complete record. This daughter was a great-granddaughter of the original foundation cow. She was said to be of much better breed type than either her dam or grand dam, but her production was only 4,850 pounds milk and 173 pounds butterfat. This was only 150 pounds milk and 20 pounds butterfat more than was produced by her great grand dam, the foundation cow.

THE PRESENT SYSTEM OF SELECTION AS ORDINARILY PRACTICED.

The present system of breeding is based on selection and may be divided into four classes. In one class are those breeders who select breeding animals by their conformation. To such breeders a bull that has won a championship at an important show is considered worthy of heading a herd of fine cows, though his pedigree or performance shows evidence of only ordinary producing ability. A cow that has ranked well up in her class in a strong show is considered a splendid foundation animal.

In the second class is the man who selects his bulls and females entirely on the strength of the records of their ancestry. Usually the greatest weight is put on the record of the dam.

In the third class is the man who selects for both type and production. This is the growing class. The animals that possess type and also have dams with good records are the animals that command the best prices in the sales ring.

In the fourth class, which may be, and usually is, a part of one of the above methods of selection, is the breeder who believes emphatically that he must stick to a single family in his selection of breeding animals. He believes that either line breeding or inbreeding is necessary in order to get desirable results.

There is, of course, the breeder who does not believe in mating related animals.

Are any or all of these methods of selection accomplishing the purpose of helping us fix the tendency for high milk-producing capacity in our dairy breeds, so that our young bulls may be expected to transmit high milk and butterfat-producing capacity with the same certainty that we expect them to transmit their breed characteristics? If not, why are they failing?

SELECTION BY TYPE.

It may be questioned whether we really know the fundamental relationship between the conformation of certain parts of the body and the functions of the body. For years dairy husbandry students have been taught in our agricultural colleges that a large heart girth in a cow means a large heart and lungs and that large heart and lungs indicate a superior constitution; that a large barrel means a

large capacity for handling feed; that well-developed milk veins mean a large flow of blood to the udder, and so on. Do we really have facts on which to base these teachings? Does a large heart girth really indicate a large heart and lungs; and if so, do large heart and lungs really mean that the dairy cow having them is more capable of heavy production of milk and butterfat than a cow with much smaller heart and lungs? Also does large stomach and intestinal capacity mean greater ability to digest and assimilate large amounts of feed? The Dairy Division is working on this problem, trying to determine the correlation between the outward measurements of the body and the size of the corresponding organs; and then the fundamental problem whether there is a relationship between the size of the vital organs and the producing capacity of the animals. It has already been demonstrated that animals with small milks veins and wells do not necessarily have a limited flow of blood to the udder, and that a part of the flow may be taken care of in the interior veins that are not visible outwardly. Even if it is found that there is a relationship between conformation and producing capacity, a favorable conformation will only indicate that it will be possible for a certain animal to produce well, provided that animal has the inheritance that will stimulate large production. Since we know that inheritance governing all characteristics is transmitted through the germ plasm, it does not seem possible that we will ever be able to tell by the appearance of an animal what its inheritance for production is. But it does seem possible that we may be able to determine the limitations of an animal to produce by its conformation. For example, if it is found that a large heart girth is correlated with a large heart and lungs, and that a large heart and lungs are essential for heavy production, and an animal is found with a small heart girth, its producing capacity will be limited regardless of how good an inheritance for great production it may possess. These things may indicate the limitations of an animal to make full use of an inheritance of great production, but it seems improbable that they will ever indicate to us whether the animal has such an inheritance. It does not seem possible to breed cattle that will be pure for the factors governing high production, by selection based on type alone.

SELECTION ON THE BASIS OF PRODUCTION RECORDS.

Selection on the basis of production records of dams is leading to a gradual improvement in the producing capacity of our purebred dairy cattle, but it is by no means a sure method of improvement. The producing capacity of our dairy cattle will be subject to great variation for years to come if we use only this method of selection. When a cow shows great producing capacity we must assume that she has at least a part of the factors in her germinal make-up that go to determine the ability for large production, otherwise she would not be a large producer. When we see a polled cow, however, we can not be certain that she does not have in her germ plasm the factors that will cause the growth of horns. And so with a cow of great producing capacity, we can not be certain that she does not have in her germ plasm the factors that will cause low pro

duction. Then too, the germinal make-up of the offspring of this high-producing cow will depend partly on the sire she is mated with. If the function of high-production is a dominant character, as it appears to be, then it will be a difficult matter by basing selection on the production records of the dam to breed a strain that will be pure for high production.

SELECTION ON THE BASIS OF PRODUCTION RECORDS AND CONFORMATION.

When the actual relation between outward conformation of the body and the corresponding organs is definitely known, and when the relationship of the size or development of certain organs and the producing capacity of the cow is known, and if these relationships are positive, then our knowledge of conformation will assist us in eliminating the animals that have a weakness that would inhibit the full development of an inheritance for great producing capacity. Such knowledge would save considerable time and effort by eliminating the use of animals that can not be of benefit in the breeding program. On the other hand, many animals are discarded because of poor individuality, though they have an inheritance for high-producing capacity that would be of material benefit in building strains that would be pure for high production. Naturally, there are many more animals that are good for either production alone or type alone than there are that have both great producing capacity and the desired type. The field of animals to be selected from, for building strains that are pure for high production, and at the same time have the factors for good type, is therefore limited.

THE PRACTICE OF MATING RELATED ANIMALS.

Breeders generally have been taught to believe that the most uniform results in breeding work will be secured by mating related animals, and especially that greater uniformity in type will be secured by this practice. But in fact, if the same general type has been fixed in two unrelated families there is no reason why the crossing of these two unrelated families should result in offspring having a great variation in type. Where families of distinctly different types are mated, a variation in type in the offspring is to be expected.

The theory that it is necessary to mate related animals, or to breed within a family, if desirable results are to be secured, has developed among our breeders to the point where it is almost a fetish. This belief is the result of both teaching and commercial practice. The fact that most of the early breeders of the English breeds practiced very close breeding in order to fix the characters they sought has been a primary reason for the practice being recommended and taught in our colleges. Probably those early English breeders had but few desirable breeding animals from which to select, and when they did find animals with the characters they wanted they had to inbreed to fix these characters because unrelated animals carrying these characters were not available. Breeders of plants and labora-

tory animals have also found that any certain characteristic could be fixed by close breeding.

Commercial practices have entered into the establishment of this theory. A breeder makes a reputation on a certain family, or strain, which he has developed. This family is advertised. Soon a group of breeders are developing and advertising this family. If the breeder who buys a bull of this family believes it is necessary to make related matings, his next bull will be purchased from the same breeder or will at least carry the same blood lines. The herd of some breeder, who has made a reputation with a certain family, may be in need of improvement that could be brought about by an outcross to another family, but the breeder will not make this outcross because he fears that to do so would mean acknowledging to the public the superiority of the other family, thereby weakening the prestige of his own family. Very often the extensive advertising of a family and the backing of that family by influential people have caused it to gain such popularity that it commands higher prices than others that have greater merit. In one of our dairy breeds one family has gained such widespread popularity that animals not having a top cross of this family can not command high prices. Commercialism has led to the breeding of distinct strains of families within breeds, and to the widespread expansion of the theory of line breeding. It has limited the selection of breeding animals to the family in which the breeder is interested. New strains have been developed with the power of great improvement, but they have died out because of inability to market the animals as a result of this aversion of breeders to mating outside their established families.

In a study of the transmitting ability of 87 Guernsey sires that were ranked both according to the average production of their daughters and according to the average increase in production of the daughters over their dams, 16 were classed as inbred, 24 were classed as line bred, and 47 were classed as outbred. Dividing these 87 sires into three groups of 29 each, the best, medium, and poorest sires, it is found that 31 per cent of the inbred sires are in the best group, 44 per cent in the medium group, and 25 per cent are in the poorest group, 46 per cent of the line bred sires are in the best group, 25 per cent in the medium group, and 29 per cent are in the poorest group; 28 per cent of the outbred sires are in the best group, 34 per cent in the medium group, and 38 per cent in the poorest group. While the greatest percentage of the line-bred sires are in the best group and the greatest percentage of the inbred sires are in the medium group, the distribution of inbred, line-bred, and outbred sires among the three groups is so even as to indicate that close breeding is not necessary in order to secure prepotency in sires. It would seem to be as possible for the outbred sire to be homozygous for the factors determining high-producing capacity, if he is the result of a fortunate mating, as it is for the inbred sire.

An interesting illustration of the effect of the different forms of mating on production ability is to be had in the daughters of three sires, father, son, and grandson, respectively, each of which had some inbred, some line-bred, and some outbred daughters. Sire A, outbred, had 2 inbred, 4 line-bred, and 11 outbred daughters. The two

inbred daughters had an average production of 756 pounds butterfat; the 4 line-bred daughters an average of 581 pounds butterfat; the 11 outbred daughters an average of 605 pounds butterfat. The inbred daughters had an average increase over their dams of 63 pounds butterfat; the line-bred daughters had an average increase of 56 pounds, and the outbred daughters an average increase of 101 pounds.

Sire B, an inbred son of sire A, has 4 inbred, 7 line-bred, and 8 outbred daughters. The inbred daughters average 690 pounds butterfat; the line-bred daughters average 762 pounds butterfat; and the outbred daughters average 675 pounds butterfat. The inbred daughters have an average increase over their dams of 29 pounds, the line-bred daughters an average increase of 193 pounds, and the outbred daughters an average increase of 56 pounds butterfat.

Sire C is a son of sire B. He is classed as line bred. He has 4 inbred daughters, 1 line-bred, and 2 outbred. His inbred daughters average 684 pounds butterfat, his line-bred daughter has a record of 406 pounds butterfat; and his outbred daughters an average of 720 pounds butterfat. The inbred daughters show an average increase of 17 pounds butterfat over their dams, the line-bred daughters an average increase of 27 pounds, and the outbred daughters show an average increase of 171 pounds butterfat.

Here are three closely related sires of unusual merit, all securing excellent producing daughters in the different degrees of closeness of mating, but each one having his highest producing daughters in a different class; that is, sire A's highest producing daughters are inbred, sire B's highest producing daughters are line-bred, and sire C's highest producing daughters are outbred. Sire B's line-bred daughters had the greatest average increase over their dams, while the outbred daughters of both A and C showed the greatest average increase. It is apparent that a daughter or son may be homozygous for the factors determining high milk and butterfat producing capacity without its sire and dam being related.

WHAT KIND OF MATINGS SHOULD BE MADE?

In order to breed animals that will have uniformly high-production ability, animals must be mated which possess only those hereditary factors that will determine high-production capacity; or at least one of the parents must possess all hereditary factors determining high-producing capacity, and they must be dominant over the factors that determine low production. In other words, in order for the F generation to be uniformly high producers either both parents must be pure for those hereditary factors that will determine high production or else one parent must be homozygous for dominant hereditary factors determining high production. The latter type of mating may get animals that will be uniformly good producers, but unless these offspring are homozygous for the hereditary factors that determine high-producing capacity they will not breed true unless the animals to which they are mated are homozygous for dominant factors determining high production. Why inbred? Why line breed? If sire A is homozygous for dominant factors determining high production and his heterozygous daughters are bred back to him, half of his inbred offspring will be homozygous

and half heterozygous. What will be the result if sire A's daughters are mated to sire B, who is also homozygous for dominant factors determining high-producing capacity, but is not related to sire A? If sire B has the same combination of factors that enables him to sire high-producing daughters, as has sire A, there is no reason why the result should not be the same as when sire A's daughters are mated back to him. In either case the percentage of offspring that are homozygous for these factors determining high production will be greatly increased. But it is not yet certain that sire A and sire B, representing different families or strains of the same breed, and both having proven by the producing ability of their get that they are homozygous for the factors determining high production, have the same factors or combination of factors that enables each of them to get the same desirable results. The indications from studies of advanced registry records are that the factors controlling high-producing capacity are alike in most highly prepotent sires of the same breed.

The advantage of inbreeding or line breeding in fixing high production is the reappearance, in the pedigree, of the sire or dam definitely known to be a great breeder. Ancestors that might be poor are eliminated to the extent of the duplication, and thereby the chances of the individual receiving the desired hereditary factors from the great breeding ancestor are correspondingly increased. Should more complete evidence show that unrelated prepotent sires of the same breed gain their prepotency through different hereditary factors, or different combinations of hereditary factors, then it may be necessary to mate closely related animals in order that the offspring receive the same combination through both parents. If, however, the evidence continues to point to the unrelated sires of a breed that are proving great breeders, all deriving their prepotency from the same grouping of hereditary factors, then the breeding of cattle that will be homozygous for the factors controlling high-producing capacity is going to be accomplished most rapidly by the continuous use of sires, within a breed, related or unrelated, that have proven by the uniformly high production of their daughters that they are homozygous for the factors controlling high-producing capacity.

Still another method of breeding is suggested by the results of Wright's guinea-pig experiments and Jones's experiments with corn. In the inbreeding experiments with guinea pigs, Wright has found that in most of the families used a decline in all the elements of vigor, as weight, fertility, and vitality, resulted from inbreeding. When these inbred families were crossed, however, there was an improvement over both parental stocks in all elements of vigor. Jones has secured similar results in crossing inbred strains of corn.

By crossing our inbred families of dairy cattle, within breeds of course, we may expect to secure cattle with greater vigor, and through the new combinations of the more dominant factors for the desired characters of the families crossed, some animals will be superior to either of the parent families. These superior animals may form the foundation herd from which new inbred families may be developed and crossed.

In the Dairy Division's breeding experiments with dairy cattle, the effects of both inbreeding and outbreeding with the same sires will be compared. The attempt to breed a line that will be pure for high production is being made by using for generation after generation only such sires as have proven their ability to transmit uniformly high production. All the bulls born in the breeding herds are being proved by loaning them to farmers who keep production records of the heifers these bulls sire. There are now over 65 bulls loaned that are being proved. Those that show indications of being homozygous for the factors controlling high production and good type will be used in the experiments.

The two most important problems in breeding animals that will be pure for high production are, first, to determine whether it is the same grouping of hereditary factors in each of the prepotent sires within a breed that enables them to transmit uniformly high production to their get, and, therefore, whether the use of these unrelated sires regardless of relationship will tend to build a strain that will be pure for the factors determining high production, and, second, if it is discovered that these prepotent sires of a breed all have the same hereditary factors controlling production, to find enough homozygous sires for these hereditary factors to enable us in the course of a few generations of breeding to produce a strain that will be pure for high production.

Chairman HILL. The next paper will be presented by Prof. L. J. Cole, chief, Animal Husbandry Division, United States Department of Agriculture, who is on leave from the University of Wisconsin. The subject of Professor Cole's paper is "The Wisconsin experiment in crossbreeding cattle." [Applause.]

THE WISCONSIN EXPERIMENT IN CROSSBREEDING CATTLE.¹

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Dairy production and beef production are both the result of two major operations—breeding and management (using the term "management" in its broadest sense, including feeding). Breeding supplies the material with which to work; management endeavors to get the most out of that material. It would be entirely gratuitous to designate one of these operations as more important than the other; the highest possible development of knowledge and skill in each is necessary to produce the greatest result, that is, not necessarily the largest, but the most economical return in milk, butterfat, or meat.

There is, perhaps, no just cause to complain of the progress which has been made in the last few decades. Particularly in the line of management has the progress been marked, especially in feeding, housing, and care; and, if we wish to go that far, in handling and

¹ Papers from the department of genetics, Wisconsin Agricultural Experiment Station, University of Wisconsin, No. 40. Published with the approval of the director of the station.

marketing the products, all of which pertain to the successful prosecution of the industry. This advance has been due in part to empirical experiment—the method of simply trying a thing out to see how it works—and in large measure to the fact that known physical and chemical, as well as physiological, laws were readily applicable to many of the problems of management in the broad sense in which that term is here used.

The progress in breeding has been fairly steady but less marked. Here it has been necessary to rely on such rules as seem to have worked in the past (and which are far from reliable) and such intuition as the individual breeder seems to possess. At any rate, the results obtained by successful breeders are often credited to their intuition, though one can not help surmising that in many, perhaps most, instances, other things being equal, the successful breeders are the ones on whom Dame Fortune has deigned to smile; for while the laws that govern the heredity of milk and meat production are as yet far from being formulated into a usable system, we do know enough about them to realize the enormous influence of the factor of chance in all breeding operations as at present conducted. It is the purpose of breeding investigations to determine the laws which are concerned, and by their application to reduce the element of chance to its lowest possible influence in breeding work. Law implies regularity, and when events occur with regularity, that is, in a predictable sequence, it opens the possibility of securing desired and uniform results.

I have often emphasized the fact that the great need of the dairyman or cattle breeder is not so much better animals than are now available, but rather to be able to produce the best at will and uniformly. This point might be expanded, but it is so self-evident as scarcely to need discussion. Some years ago the animal husbandry department of the University of Wisconsin issued a statement to the effect that the average cow in the State of Wisconsin barely paid for her keep in the course of a year. This means that some of the animals more than paid their way, while others were an actual liability. The condition of the financial balance sheet of the dairyman naturally depended on whether his herd contained a larger proportion of the one kind or the other.

While the art of breeding has made great progress in the production of high-yielding animals with respect to both milk and meat, there is, nevertheless, a great lack of uniformity among the offspring of even the most expertly bred stock, and the proportion of these which meet the ideals of the breeder is relatively very small. It is notoriously true that high-producing animals can by no means be depended upon to produce uniformly high-producing offspring. Even animals which appear to be, in all outward respects and with respect to production, very similar may be very dissimilar in the character of their offspring. Unfortunately, moreover, beyond certain general tendencies of growth, which are commonly interpreted as indicating, for example, a "dairy temperament," there is no reliable criterion by which a young animal may be picked out as a future good producer. Even the criteria of breeding (that is, pedigree) and dairy temperament sometimes fail, for it is well known that cows not favored to a high degree in either of these respects

often prove to be the peers of other animals which have been most carefully bred and selected. The difference usually appears in their progeny—the progeny of the poorly bred animals will in all likelihood vary greatly, and few of them will be of value, even approximating that of their mothers. On the other hand, a large number of uniform and high-producing offspring may be expected from the more carefully bred parent. In the case of dairy cattle another problem is introduced in the selection of the male parent, for the reason that there is no means of measuring directly in his case the condition of those characteristics for which selection is being made.

It was the conviction that what was needed was more accurate data on the inheritance of all characters in cattle, if any real advance in the understanding of their heredity was to be made, that led to the initiation, in 1912, at the Wisconsin Experiment Station of an experiment designed primarily to help furnish these facts. This was to be conducted in so far as possible as a strict genetic experiment along the lines which the work of the earlier years of the present century, following the lead of Mendel, had shown to be most fruitful in genetic results, namely, by the crossbreeding of animals showing marked differences. Since this necessity is not always clear to the layman, and genetic experiments are frequently criticized because of their "impractical" nature, an analogy may help to make our position clear.

If we had a snarl of yarns and we desired to trace through the tangle certain particular threads, this task would be much facilitated if the threads we sought to follow were of some distinctive color, different from the others, and readily recognizable. In just so far as the threads were strikingly different in color, our task would be easier; while if they were of shades so nearly alike as to make them difficult to distinguish, it would be impossible to follow them individually for any distance. This figure illustrates the difficulties which beset us in attempting to trace the individual hereditary factors involved in any complicated function, such as milk production, and it was for this reason that in the proposed experiment animals were selected for the original parents which differed widely with respect to as many characters as possible. It was hoped that on account of this difference these characters might be recognized through subsequent generations, and so the factors which produced them might be traced. It was with this in mind that the two breeds originally chosen to be crossed were the Jersey, representing the greatest refinement of breeding toward dairy production, and the Aberdeen-Angus, as a correspondingly specialized beef breed. Since then the Holstein-Friesian has been substituted for the Jersey for reasons which will be mentioned.

It should perhaps be further emphasized that this experiment contemplated no immediately applicable practical result, such as the production of a new breed combining the desirable characteristics of the breeds crossed. There has been no attempt nor intention to "produce" anything, but rather, by the accumulation of data, to supply knowledge as to what we might reasonably expect to be able to produce and how to go about it. This explanation is important in distinguishing this investigation from other crossbreeding experiments with cattle which preceded it and some of those which have been undertaken since.

It must not be supposed that we were so sanguine as to believe that a single experiment with animals which breed so slowly and are so expensive to maintain could be expected to go far in solving the more difficult problems involved, especially within a limited period and with such limitations as the conditions imposed. It was felt, however, that we were making a start toward the securing of definite facts which must be accumulated before any great advance in our knowledge of inheritance in cattle could be made. It was hoped that other experiments of a similar character would be undertaken elsewhere, and that eventually the combined results of them all would lead to material progress. It is a source of satisfaction that data of this sort are now being accumulated in a number of places by this and other methods of research which should add within a reasonable time greatly to our knowledge of the inheritance and the best methods of breeding in cattle.

Ten full years of data have now been secured, but up to this time no serious attempt has been made at their analysis, as it has seemed desirable first to secure a reasonable accumulation. We are at present, however, engaged on their study and hope in the near future to present at least some of the more definite results. In the meantime, and especially with the time at my disposal, it is not possible to give more than a brief statement of some of the more outstanding facts.

The idea of the experiment was to keep full and accurate records on all characters in which the breeds differed or in which there was sufficient variability to permit of accurate description or measurement. The success with which this could be done has depended in large part on the facilities for securing the data; in some cases the records are complete, but in others it has been possible to make only general notes and descriptions. Among the records which have been taken most systematically may be mentioned the following:

1. Accurate pedigree records.
2. Body characters.
 - a. Weight: Taken at birth and at weekly intervals.
 - b. Measurements: Some 30 or more measurements on each animal at stated intervals.
 - c. Photographs at regular periods.
 - d. Udder and milk veins: Size, shape, texture.
 - e. Coat: Color, markings, density, length.
 - f. Horns: Presence, length, shape, color.
3. Skeleton: Characters of the skull and of certain other bones.
4. Milk production.
 - a. Duration of lactation.
 - b. Quantity, by weight.
 - c. Quality: Fat percentage (weekly); monthly determination of specific gravity, total solids, butterfat, protein, casein, ash, sugar, viscosity, and Hübl and Reichert-Meissl numbers of the fat.
5. Behavior: Relative docility.
6. Slaughter data: Dressing percentage, distribution and color of fat, weight of blood, hide, and internal organs, weights of retail cuts, chemical determinations of fat.

In addition, naturally, many observations have been made which are of interest, even though too scattering to be of statistical use. It should be mentioned that the effort has been made to keep the conditions of feeding and management as uniform as practicable throughout. Time will permit mention of only a few of the more obvious results of the experiment to date.

THE JERSEY-ANGUS CROSS.

The original stock for this cross consisted of two purebred cows of each breed, supplemented later by a third Angus cow. These cows were bred reciprocally to bulls of the other breed, and from them 12 individuals of the first generation have been obtained. Seventeen second generation offspring have been produced from females of this first generation bred to a bull of the same generation; 3 from first generation cows bred back to a Jersey bull; and 9 from second generation females by a Jersey bull.

In the case of some of the more obvious and genetically simple characters, the results tend to confirm those of earlier studies; regarding the more complicated characters only indications can yet be mentioned, at least until more complete analysis of the records has been made.

Color.—The black of the Angus appears to be completely dominant to the various shades of fawn of the Jersey; the crossbred progeny are all black, with no greater variability in intensity of the color than is found in purebred Angus. In the second generation and in the back crosses there is much variability, as is to be expected. Some of these resemble the very dark type of Jersey, formerly much more common than now, and others are as light as a typical Guernsey, even including light muzzle and hoofs. In no case so far, however, has the typical light fawn of the Jersey been exactly reproduced. It may be a curious coincidence, or it may have a deeper significance, that all the lighter-colored individuals appearing in these later generations have been males. In general it would appear that black behaves as a single-factor Mendelian dominant to the lighter shades; but there is obviously a complicated set of factors responsible for the variation in the lighter colors. Brindling, for example, appears rather frequently, and it is not yet certain whether it is due to a factor carried (as a cryptomere) in one or the other of the parent breeds or whether it is the result of complementary genes coming from the two parents.

White spotting, except for a small amount of white on the udder and underline, does not enter into this cross.

Horns.—The polled condition of the Angus is again a dominant. The crossbreds are uniformly polled if we except the irregular appearance of scurs. These are usually absent or small on the females, but may reach a length of several inches on the males, particularly on those which are not castrated at an early age. The extent to which the development of the ectodermal corneous growth is genetically or physiologically correlated with the presence or absence of a bony core has not yet been fully determined, but it is hoped that a careful study of the series of skulls may throw some light on this.

Conformation.—As was perhaps to be anticipated, the conformation of the crossbreds is in a general way intermediate, but it has shown rather surprising variability. This is due very likely to the lack of genetic constancy of the factors governing conformation in the two original breeds. There seems to have been a tendency for the crossbreds in most cases to resemble more in conformation the breed of their sire than that of their dam, but this may of course

be a coincidence, due to the genetic peculiarities of the particular individuals used.

Milk production.—The meager records at hand indicate a milk production of the crossbreds intermediate between that of the two original breeds but with high production tending to be dominant. The higher production of the Jersey is due to both a greater milk flow and a more sustained lactation period. In both these characteristics the crossbreds resembled more nearly the Jersey. It has already been mentioned that in conformation they resembled their sires more than their dams and the same may be said of milk production—the crossbred cows from Jersey sires were in all respects more truly dairy animals than those from Angus sires. But again it must be pointed out that a generalization from this would not be justified, because of the small numbers involved.

THE HOLSTEIN-ANGUS CROSS.

After the experiment had been under way for some time it was recognized that it would be advantageous if there were greater difference in size and in amount and quality (per cent fat) of milk in the parent breeds than existed between the Jersey and Angus. Accordingly, as opportunity offered, Holstein-Friesians have been used to replace the Jerseys. In procuring new stock, as funds were not available for purchasing high-grade purebred animals, advantage has been taken of the fact that recessive red offspring occasionally appear in both breeds; that is, self red Angus and red-and-white Holsteins. These animals are as strictly purebred as their parents, but because of the undesirable color can not be registered, and hence can be procured at market prices for beef. In some cases they have been generously donated for the experimental work. They not only answer the purpose of the experiment fully as well, but have the advantage that they give opportunity for study under controlled matings of the inheritance of the red color.

Some 15 first-generation calves produced from this cross up to the time of writing show the dominance of polled over the horned condition of the Holstein just as over the Jersey. The black color of each breed is also definitely dominant over the recessive red of the other. The self color of the Angus almost completely dominates the white spotting of the Holstein, but the crossbred calves nearly always have at least a small white blaze on the face and often white on the feet, in addition to a variable amount of white on the udder and underline.

There appears to be more evidence of "hybrid vigor" in this cross than the other; at any rate it gives strong, quick-growing calves and produces steers which give promise of being of excellent quality. The results suggest that a dairyman having a herd of grade Holstein cows which he wishes to have freshen, but from which he does not care to raise the calves, might do well to breed the cows to a purebred Angus bull of good quality. This would give him a crop of uniformly black calves far superior to purebred or grade Holsteins for vealing or for sale for fattening as yearlings.

Chairman HILL. Has anyone any questions to ask Professor Cole?

Mr. M. A. O'CALLAGHAN (chief of the Dairy Division of the Commonwealth, Australia). This paper follows the lines which I adopted in 1898 in connection with breeding in Australia. Instead of using the Jersey and the Angus I used the Guernsey, the Ayrshire, and the Holstein-Friesian, and mated, on the sire side, these breeds with Shorthorns selected from a beef cattle station in Australia, which had been used for production of beef only, so far as we could trace. Some of the results I published in 1921. They went to show very clearly that, generally speaking, when we selected a dairy sire of long pedigree from heavy milk and butterfat producing stock, the daughters in almost every case exceeded by far what was expected in the way of production. This confirms the belief that far back in history the production of milk, as far as bovines are concerned, took precedence over the production of beef, and that we may breed out beef readily by the introduction of breeds and sires of a dominant milking characteristic.

As the published results show, we were more successful in getting high production from the same individual of the beef strain when we used the Guernsey sire than when we used any other sire. I was most unlucky in using the Holstein-Friesian, because I had a succession of males from the three or four particular cows I used.

By following the Guernsey-Shorthorn cross, using a bull obtained from that original imported Shorthorn cow, representing two lines of Guernsey blood and one line of imported dairy Shorthorn blood, traceable back for at least 20 generations, we obtained a bull which was named "Experiment No. 1." He was mated with an Ayrshire cow, and the result was a type of dairy animal of almost ideal dairy shape and conformation. The Guernsey color prevailed, and three notable cows were obtained which in every instance proved high-production animals. The fat tests were higher than those of the Ayrshire, but not quite as high as the standard of the purebred Guernsey, and we are now breeding again from a cow obtained from one of those strains, mated with a Guernsey bull.

Chairman HILL. The next paper is "The inheritance of milk production and butterfat percentage," by John W. Gowen, biologist, Maine Agricultural Experiment Station, University of Maine, Orono, Me. [Applause.]

THE INHERITANCE OF MILK PRODUCTION AND BUTTERFAT PERCENTAGE.

JOHN W. GOWEN, PH. D., biologist, Maine Agricultural Experiment Station, University of Maine, Orono, Maine.

A combination of choice by type, choice by pedigree, and choice by performance is now made to select the cattle to complete our dairy herds. It is to be hoped that the next step will be choice by progeny performance, for the recent studies of the inheritance of milk yield and butterfat percentage all indicate this method as the most promising for improvement in the production per cow. In this paper the attempt will be made to review briefly the influence which these

methods of choosing dairy cattle may have on the milk yields and butterfat percentages of the cows of the future, as judged by the effect they have had on the cows of the past.

The only extensive records of type, in relation to milk production, with which the author is familiar, are those collected by the American Jersey Cattle Club. Thanks to the courtesy of this club, the writer has been able to analyze these records. The outcome of this analysis shows that the relative merit of the more important parts of conformation for distinguishing the high milk-producing cow from the low milk-producing cow is: Total score—milk veins, large, tortuous, and elastic; rear udder well rounded, and well out and up behind; udder large size, not fleshy; body wedge shaped, with large deep paunch; neck, thin, long, with clean throat, thin at withers; general appearance—teats, good, uniform, well placed; rump, long and level; thighs, flat and well cut out.

These points appear valuable to the average trained dairymen. However, no one person is average, and to the individual person, these points do not necessarily have the same values for determining milk yield. Thus, of the 19 judges (each judge scoring more than 20 cows), 9 could judge dairy cattle by the score card and select the better milkers, 8 were only fair judges, and 2 gave the lower-producing cow the higher scores. The evidence further shows that the good judge for one part of conformation tends to be the good judge of the cow's milk yield from the other conformation points. In other words, judging ability is a generalized ability. These facts show that a personal equation exists for each judge which influences markedly his ability to choose the high-milking cows from the herd. Furthermore, even if the best judges are considered, the values of the different points of conformation in indicating milk yield are relatively slight. In fact, a record of so short a time as seven days is about twice as good an indicator of milk yield over the full lactation period as the conformation of the cow, even though this conformation be judged by men of experience and proved ability. Moreover, conformation has no relation to the butterfat content of the milk. In view of these facts, the trend toward the subordination of type to proved productive worth appears justified.

In the choice by pedigree are included those cases where the valuation of the breeding animal is based on the study of the pedigree to ascertain the inbreeding and the lines of descent, as determined by famous animals appearing in the ancestry. The supposed value of the animal in question is then based on these points, even though the famous ancestors are generally more than two generations removed. Certain of our studies with the Jersey and Holstein-Friesian breeds bear directly on these questions.

Inbreeding studies were made on a group of sires whose daughters were high producing, a group whose daughters were low producing, and a group composed of a random sample of the breed. Two other groups, sires whose daughters were high in butterfat percentage and sires whose daughters were low in butterfat percentage, were also studied.

The results derived from the two breeds are in essential agreement on the following points: The average of inbreeding and relationship in the four generation pedigrees of the different groups.

whether of high or low milk yield, is low, the highest average being only about 10 per cent. The average inbreeding and relationship for the sires of the high milk-yielding daughters was greater than for the sires of the low milk-yielding daughters. The same is also true for the sires of daughters whose butterfat percentage is high versus those whose butterfat percentage is low. The random sample group of sires without advanced registry daughters has a slightly greater inbreeding and relationship than any of the four other groups of advanced registry animals. In view of this evidence, the fear that inbreeding and relationship within a pedigree in the amounts normally found in the different breeds would affect detrimentally the resulting offspring does not appear to be justified. Critically considered, the inbreeding or relationship found in the pedigree of a bull is of little or no value as a standard by which to select breeding sires.

In selecting a breeding animal, the prospective buyer usually studies the pedigree, and if it contains animals which are recognized as famous, the value of the cow so pedigreed is increased. A little consideration generally shows that these famous animals are in the third or fourth generation of the pedigree. This method of pedigree study is also advocated for determining the value of different families, with the intention of using the corollary that a cow which traces to the highest producing of these families is better than one which does not. The five groups of sires indicated above offer excellent material to determine the worth of this method of pedigree study in evaluating the probable producing capacity of the animal for milk yield or butterfat percentage. In the study of the five groups of pedigrees, it was shown that certain animals like Paul De Kol, De Kol 2d's Butter Boy, De Kol 2d's Paul De Kol, De Kol 2d and Netherland Hengerveld appear frequently in all groups of Holstein-Friesian cattle pedigrees, whether these pedigrees be for sires of high or low milk-yielding daughters, high or low butterfat-testing daughters, or a random sample of the breed. Furthermore, the animals which were most likely to be noticed in this method of pedigree study are those which are in the third or fourth generation. Taking the five groups of pedigrees as a whole, the nearly equal frequency with which any given bull or cow appears in the five groups makes it clear that the appearance of a supposedly worthy ancestor in a pedigree indicates little as to the real worth of the animal pedigreed. The size of the cross correlations for the frequency of the appearance of the ancestors in separate groups, like milk yield and butterfat percentage, shows that the popularity of an ancestor, or some similar cause, rather than the true worth as a producer, plays a large part in causing the appearance of an animal within a pedigree, and that the mere fact of this appearance is but a very thin thread on which to evaluate the productive capacity of the animal so pedigreed.

The third common method of determining an animal's breeding worth is the Babcock test, or the performance of that animal at the pail, the inference being that the better the animal in these respects, the better will it be in transmitting these qualities to the progeny. While this is undoubtedly a fair supposition, modern breeding has shown many cases to the contrary. Little or no critical evidence has been presented on the problem in cattle. In fact it can scarcely

be said that we knew, until recently, that milk yield or butterfat percentage were themselves inherited, or how the inheritance took place. This problem has occupied much of the writer's attention for a number of years; and while many of its phases are still unknown, a number of its more important parts have been solved.

Within any pedigree the only animals with records for milk yield are the cows. The bulls have to be judged by their dams' records. There are several possible combinations of records between the different members of a pedigree. The study of the performance of the animal in relation to her breeding worth shows much in common with progeny performance records. Among the possible combinations of records may be considered the relation between the record of the daughter and dam, the record of the granddaughter, and the two grand dams, maternal and paternal. Among the close relatives, the relation of the milk yields and the butterfat percentage of full sisters and half sisters, when the sire is the common parent and when the dam is the common parent, is important. These different combinations of relationships have been studied for the Holstein-Friesian 365-day records. Previous to any study of milk records, the necessary correction for age should be made. This correction has been made for all data used in this paper. The results accruing from a study of the milk yield of mother and daughter may be illustrated as follows:

There were 611 pairs of mothers and daughters, each of which had 365-day records. The daughters' milk yield was slightly in excess of that of their dams. The average milk yield of the daughters was 19,600 pounds. Their dams' average milk yield was 18,830 pounds when properly corrected for the effect of age. There are 216 daughters who came from dams whose milk yield was over 20,000 pounds. These daughters' average production was 21,778 pounds of milk for the 365-day period. The 395 daughters, who came from dams whose milk yield was less than the 20,000 pounds, had an average production of 18,393 pounds. In other words, the daughters from cows whose production was greater than 20,000 pounds had a milk yield 3,385 pounds greater than the daughters which came from dams whose milk yield was less than 20,000 pounds. The tabulation of the expected milk yield of different grades of dams' milk production is given below. This is the average expected milk production of the daughters, and is not necessarily the milk yield that a single daughter will give.

TABLE 1.—*Milk yields of dams and the average yield of their daughters, Holstein-Friesian advanced registry.*

Milk yield of dams.	Expected average milk yield of daughter.	Milk yield of dams.	Expected average milk yield of daughter.
<i>Pounds of milk.</i>	<i>Pounds of milk.</i>	<i>Pounds of milk.</i>	<i>Pounds of milk.</i>
10,000	15,081	22,000	21,230
12,000	16,106	24,000	22,255
14,000	17,131	26,000	23,279
16,000	18,155	28,000	24,304
18,000	19,180	30,000	25,329
20,000	20,205		

In studying Table 1, it will be noted that when the milk yield of the dam is low the milk yield of the daughters tends to be higher; the daughters tend to revert toward the average milk yield of the breed. On the other hand, when the milk yield of the dams is large the milk yield of the daughters is less; again they tend to revert to the average of the race. The significant fact is not so much this regression; it is rather that the higher the milk yield of the dam, the higher the milk yield of the daughter, on the average.

Those who are familiar with milk yield of dairy cattle are cognizant of the fact that all the daughters of 20,000-pound dams will not have milk yield of 20,205 pounds. This will be their average, if there are enough of them; but individually they will vary. What we want to know is, how much will they vary from the average of 20,205 pounds? Suppose we say that it shall be an even chance that any one daughter will lie inside or outside a certain range of milk yield. Thus, if we had 100 daughters which came from dams producing just 20,000 pounds of milk, the milk yield of 50 of these daughters would be expected to lie with 17,787 pounds as the low limit, and 22,623 pounds as the high limit of production. The other 50 would be expected to be either under or over the limit of production. The milk yield shown in the next table gives the limit of milk production between which would lie the milk yield of 50 per cent of the daughter cows from dams of a given grade of milk production.

TABLE 2.—*Milk yields of dams and the limits between which would lie the milk yield of 50 per cent of their daughters.*

Dams' milk production.	Range of milk yield of 50 per cent of the daughters.	Dams' milk production.	Range of milk yield of 50 per cent of the daughters.
<i>Pounds of milk.</i>	<i>Pounds of milk.</i>	<i>Pounds of milk.</i>	<i>Pounds of milk.</i>
10,000	12,660 to 17,500	22,000	18,812 to 23,648
12,000	13,688 to 18,524	24,000	19,837 to 24,673
14,000	14,713 to 19,549	26,000	20,861 to 25,697
16,000	15,737 to 20,573	28,000	21,886 to 26,722
18,000	16,762 to 21,598	30,000	22,911 to 27,747
20,000	17,787 to 22,623		

It will be noted that there is a wide range of production to include even 50 per cent of the daughters of a given grade of dams' milk yield. Thus 100 daughters from dams whose milk yield was 20,000 pounds would be expected to have a certain range of milk yield. Fifty of these daughters would be expected to have a range limited on the low side by 17,787 pounds of milk and on the high side by 22,623 pounds of milk. It will be noted that as the milk yield of the dams increases, the milk yield of the daughters also increases.

The above table gives us the limits of milk yield between which we would expect 50 per cent of the daughters of dams of a given grade. It may now be asked, between what limits should I expect to find most daughters of the dams of a given grade of milk yield? Before answering this question I shall define most as 99 per cent of the daughters. When so defined, the limits of production wherein

we would expect to find 99 per cent of the daughters are given in Table 3.

TABLE 3.—*Range of milk production within which would be expected 99 per cent of the daughters from a given grade of dam.*

Dams' grade of milk yield.	Range of milk yield of 99 per cent of daughters.	Dams' grade of milk yield.	Range of milk yield of 99 per cent of daughters.
<i>Pounds of milk.</i>	<i>Pounds of milk.</i>	<i>Pounds of milk.</i>	<i>Pounds of milk.</i>
10,000	5,832 to 24,330	22,000	11,981 to 30,479
12,000	6,857 to 25,355	24,000	13,006 to 31,504
14,000	7,882 to 26,380	26,000	14,030 to 32,528
16,000	8,906 to 27,404	28,000	15,055 to 33,553
18,000	9,931 to 28,429	30,000	16,080 to 34,578
20,000	10,956 to 29,454		

Table 3 shows the range of milk yield of 99 per cent of the daughters from any given grade of dam. This range is quite large. However, when it is realized that even this range of productivity is now and then exceeded, it shows how extreme the limits of milk yield may occasionally be. It is noticeable, however, that the daughters from low-producing dams do not milk as much as the daughters from the higher producing dams. The dams' milk yield clearly plays a part in their daughters' milk yield, and this part is of no mean importance.

Space will not permit the discussion of all possible combinations of the progeny and ancestors in the same manner. The points may be equally well brought out, however, in the shorthand of a slightly more technical discussion of the subject. A comparison of the milk yield of half sisters and full sisters furnishes a criterion for determining within what limits the milk yield of a cow is determined by the sire or dam, or by both jointly. The correlation coefficients for the milk yields of full sisters is 0.55; that for the half sisters when the sire is the common parent is 0.37; and that for the half sisters when the dam is the common parent is 0.38. It is clear that the joint influence of the sire and dam make for a greater resemblance between the full sisters than either of the half sisters. The influence of the sire or dam on the milk yield of half sisters is approximately equal. While this illustration by no means exhausts the possibilities of the proof, it is indicative of the fact, confirmed by several other lines of investigation, that the bull and cow are jointly and equally responsible for the milk yield of their daughters.

For the grandsires, the comparison of the milk yield of their granddaughters furnishes one method of proving that those ancestors influenced the milk yield of their granddaughters. The correlation coefficient between the granddaughters' milk yield for the paternal grandsires is 0.07, while that for the granddaughters of the maternal grandsires is 0.24. Clearly, the two grandsires do influence the milk yield of their granddaughters. Further, it is clear that the grandsires are only about half as effective as either of the parents. The differences between the grandsires need not be considered at this time, suggestive though it is.

The direct relationship of the milk yield may be considered for the female side of the pedigree by determining what influence the grand

dams may have on the milk yield of their granddaughters. The correlation coefficient between the milk yield of daughter and dam is 0.50. The correlation coefficient between the milk yield of daughter and paternal grand dam is 0.26. The correlation coefficient between the daughter and the maternal grand dam is 0.31. Here the influence of the grand dams is apparently equal and only about half that of the mother. Thus the influence of the grandparents is only about half that of the parents. It is perhaps unnecessary to carry this analysis to the great-grandparents, although this has been done for some of my work. Suffice it to say that the great-grandparents show little direct influence on the milk yield of their great-granddaughters.

Similar relationships to those given for the milk yield exist for the butterfat percentage. The correlation coefficient for the butterfat percentage of full sisters is 0.46; that for half sisters where the sire is the common parent is 0.38; and that for half sisters where the dam is the common parent is 0.17. The correlation coefficients for the granddaughters of the paternal and maternal grandsires are 0.18 and 0.24, respectively. The direct relationship of the butterfat percentage of daughter and dam is 0.41. The correlation coefficients for the granddaughters' butterfat percentage with the paternal and maternal grand dams' butterfat percentage are 0.09 and 0.19, respectively. These constants make it clear that the same general relationships exist for the inheritance of butterfat percentage as exists for milk yield. In other words, the bull and cow are jointly and equally responsible for the milk yield and butterfat percentage of their daughters. The grandparents influence the milk yield or butterfat percentages of their granddaughters to only about half as much as the parents affect these variables.

The performance records of the cow in the influence on the cow's progeny is without doubt differentiated according to the place the cow appears in the pedigree in relation to whether the progeny are offspring, granddaughters, or great-granddaughters. The further removed the animal (and it takes but a generation to make a pronounced effect) the less the influence of that ancestor's production on the production of the descendants. This in a large measure explains the failure of the family, or famous ancestor, method of pedigree study as a reliable criterion of the probable production of the cow.

There is one other point which might occur to the reader, that since the individuals in any one pedigree are largely owned by one man or firm, the differentiation of the animal might be due to feeding and care, and not due to inheritance. The analysis of the relative influence of these two variables is difficult and tedious in the extreme. While it is too long to present in detail, it may be said that the analysis of this question has shown that the differentiation found between the cattle owned by different firms is due practically entirely to a difference in germ plasm, the higher producing herds having a better inheritance for milk yield and butterfat percentage than the lower producing herds.

Certain facts of practical importance may be derived from these results. A record on a full sister is equal to a record on the dam for predicting the milk yield or butterfat percentage of a cow.

Likewise, the record of a full sister is equal to a record for milk yield on a sire, were it possible to get one, in predicting the milk yield of a cow. Milk yield and butterfat percentages are equally inherited from the sire and dam.

Chairman HILL. The next paper on the program is "Causes of variation in milk secretion and their bearing on practical breeding methods." by Dr. T. U. Ellinger, assistant director, Armour's Livestock Bureau. [Applause.]

CAUSES OF VARIATION IN MILK SECRETION AND THEIR BEARING ON PRACTICAL BREEDING METHODS.

TAGE U. ELLINGER, SC. D., assistant director. Armour's Livestock Bureau, Chicago, Ill.

The investigation, of which some of the main results are outlined in this paper, was based on perhaps the most extensive breeding experiment with dairy cattle ever undertaken. Incidentally, these experiments were not planned and carried out for the purpose of genetic investigations, but rather to conduct an economic study of the relative value of two breeds of dairy cattle and different kinds of crossbreds. The records, however, contained an abundance of detailed information which furnished a most interesting and appropriate material for genetic research, although a geneticist, conducting such an experiment, probably would have planned it somewhat differently in order to have the material better balanced and in some respects more extensive.

The experiments referred to were conducted by the Counts Ahlefeldt-Laurvig at Tranekjaer Castle, Denmark, in cooperation with the agricultural experiment station at Copenhagen. An annual report, covering 10 years, has been published by the station. This report was, however, almost entirely devoted to detailed studies of the economic questions involved, while the biological problems were hardly touched upon. It was my privilege to be entrusted with all of the original records in order to utilize them for genetic research, which was carried out at the University of Illinois and at the Bussey Institution in Harvard University.

The material involved in the studies to be outlined consists of detailed information and weekly records for about 250 Red Danish dairy cows, about 150 Jersey cows, about 80 crossbreds, 75 back crosses to Jersey, 25 back crosses to Danish, and, finally, 25 second back crosses to Jersey. Each animal has been tested regularly throughout its life for milk yield and fat percentage.

Although the present investigation was primarily planned as a study of inheritance problems, it soon became evident that a thorough study of the causes of variation in milk yield was necessary before the problem of inheritance could be approached. The greatest difficulty in genetic studies as well as in practical breeding work is the multitude of causes which influence milk secretion, and the resulting perplexing problem as to how to get a reliable measure of a cow's milk-yielding ability. So far no perfect solution has

been offered, and any collection of data and discussion which clarify the problems involved are most timely.

We have been accustomed to consider causes of variation to fall within two general groups. The first comprises the internal or in-born qualities which vary individually and are transmitted from parents to offspring, following more or less complex modes of inheritance. These variations are those which are of importance in breeding practices, which aim to improve the quality of livestock. Unfortunately these innate variations can not directly be distinguished from the second group of variations, those caused by different environmental conditions, such as food, management, climate, etc. The problem is further complicated by developmental factors which act throughout the life of the animal. To eliminate the disturbing effect of external causes of variation in order to display the inborn differences, it is necessary to study the effect of each environmental factor on the total variation.

We shall first consider some of the factors which influence the quantity of the milk flow during the lactation period and during parts of this period. Everything else equal, it is obvious that the length of the lactation period stands in a very direct relation to the total amount of milk secreted in this period. There are several factors which might have a determining influence on the duration of secretion. It might, for instance, be possible that the cow which starts off as a heavy milker might also keep on milking longer, or it might be possible that the cow displaying a rapid falling off in the daily milk yield record might go dry earlier than the cow which keeps up her milk production better. Careful statistical studies, however, fail to give any evidence that there is any relationship between length of lactation period and the factors mentioned.

On the other hand, there is a correlation of over 0.9 between the time of successful breeding, measured by the interval from birth to breeding, and the length of the lactation period. Time of breeding, therefore, almost entirely accounts for the variations in the length of the milking period. As this variation is very considerable, expressed through a standard variation of seven and a half weeks, it is evident that if the total amount of milk in a lactation period is used to indicate the cow's milk-yielding capacity and no account is taken of the time of breeding, the individual variations found do not very well indicate individual qualities of the animals. The observed variations are to a great extent determined by a factor which has no relationship to the constitution of the animal.

Some important statistical facts are brought out if we divide up each lactation period into sections of 10 weeks, for instance. The degree of variability is best expressed by the coefficient of variation. Calculating this coefficient for the first four 10-week sections we get the following values: From the Red Danish material, 19, 20, 23, and 37; from the Jerseys, 21, 22, 23, and 39. This regular increase in the coefficient of variation in the course of the lactation period indicates that new causes of variation appear during this period, or that a cause of increasing importance influences the amount of milk secreted. It is natural to attribute this effect to the time of breeding and, correlating this factor with the amount of milk produced in each 10-week section, we get the following results: For the Red

Danish material, 0.07, 0.12, 0.23, and 0.55; for the Jerseys, 0.09, 0.16, 0.25, and 0.55; the probable errors being around 0.05. These coefficients demonstrate clearly that time of breeding not only determines the length of the lactation period but also to a great extent the amount of milk secreted within the periods. This influence, however, is not significant for the first two 10-week sections of the lactation period. In the latter two 10-week sections, on the other hand, the correlations are significant, and highest in the last one. As the milk yield in the first and second 10-week sections is, therefore, to a greater extent determined by innate factors, they are obviously a better measure of a cow's milk-yielding ability than the records covering a longer period.

There are a number of other important causes, which, more or less, influence the milk secretion. The effect of age has been extensively studied and a high correlation between the yield in successive lactation periods has been demonstrated.

The age of the heifer at the time of her first calving very materially influences the milk flow of the first lactation period, and some grouping of the material is necessary to get directly comparable data. Two age groups, one from 24 to 27 months of age, and one 28 to 35, have proven satisfactory in the present material.

The greatest difficulty in securing data which are as little as possible or as uniformly as possible affected by external causes arises from the climatic and seasonal conditions. Cows calving in the spring yield considerably more milk than cows calving in the fall. This difference did in the present material amount to as much as 16 per cent. As the same month in different years may vary very considerably in its effect on the milk yield, this is probably one of the greatest difficulties involved in work of this kind. It may be possible, if suitable test material is available, to attribute an index value to each specific month, although such an attempt has not been made in the present investigation.

Attempts have been made to express the milking capacity of cows in a great many different ways. The actual milk yield over a longer period, such as a calendar year, a lactation period, or an eight month period, has been used, and corrections for age have been worked out. Another method of procedure has been to use the records for a shorter period of time, as, for instance, seven days, or the three days of maximum production, or, as in my preliminary publication, the first 10-week section of the first lactation period.

A problem of similar nature has been confronting the poultry raisers who breed for high egg production. Egg production is another quantitative character which is greatly influenced by innate as well as environmental factors. Some poultry breeders use the annual records for their trap-nested stock. In recent years, however, preference has quite commonly been given to the records for shorter periods, especially to those for the first months of the first laying period. A similar system has many advantages applied to dairy cattle. There has been shown to be a high correlation between the milk yield in the first lactation period and the yield in the later periods. This means that the genetic differences between individual cows are clearly displayed already in the records of the first lactation period. It is, therefore, possible to make effective selections on

the basis of the milk records of the heifer, without waiting for years for further records. Moreover, the first lactation period is not preceded by any activity of the milk glands, the function of which may later be influenced by previous activity.

It has been mentioned, however, that the records for a whole lactation period, or for a section of it longer than about five months, are less desirable because they are materially influenced by the time of successful rebreeding. Which short period comes nearest to the ideal is somewhat questionable. Under the same environmental conditions the record for the first 10-week section is practically as reliable as the record for twice as long a time. In the present investigation this first 10-week section of the first lactation period has therefore been used as indicator of milk-productive ability. It is, however, necessary to make some grouping of the material as to age and

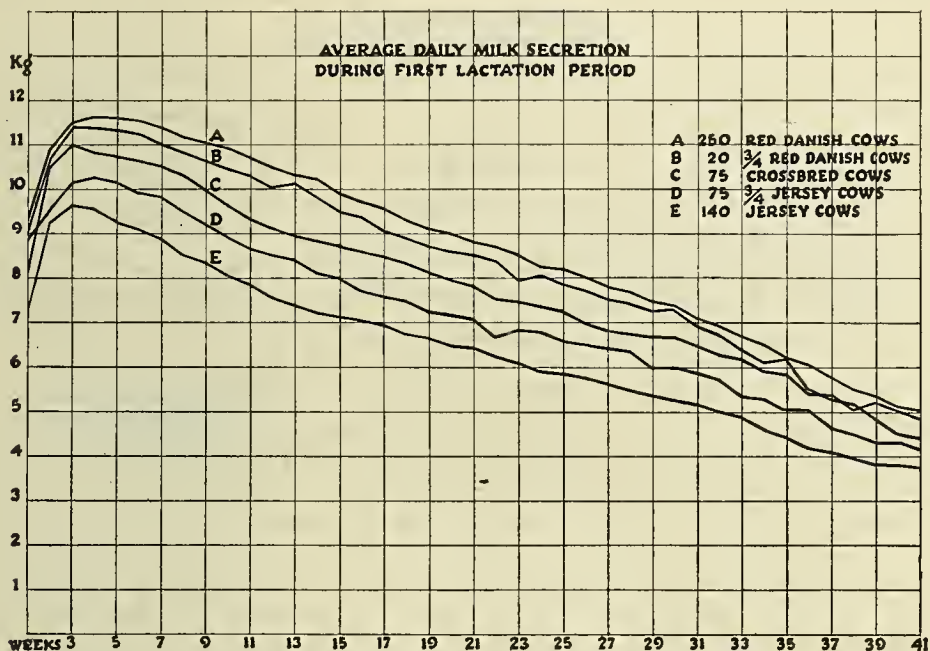


FIG. 1.—Average daily milk secretion during first lactation period.

season or to make suitable corrections, although the latter method should not be adopted in breeding work if there is a possibility of using uncorrected records. It may be possible, however, that a 20-week period would have one advantage over a 10-week period, in that the changing environmental conditions would be more equalized over the longer period. It would be a comparatively easy matter to show statistically if such an advantage really exists in favor of the records covering 20 weeks, or if 10 weeks do quite as well.

The fat percentage changes during the lactation period, but in a different way for different breeds. The Jersey starts off with the lowest fat percentage just after calving, and it increases from then on regularly, the records displaying a straight line when plotted. The Red Danish breed, on the other hand, begins with a maximum fat percentage, from which there is a regular falling off for the first two months, after which period the percentage increases again, ending about where it started. The average records for either 10 or

20 weeks are probably as exact indicators of the cow's qualities in this respect as any.

A question of great importance in breeding practice is if there is any relationship between milk amount and fat percentage. The results of studies regarding this question are quite inconsistent and depend apparently on the material involved. In the present study it has been found that in the Red Danish material the two variables are quite independent, while the Jersey material shows a negative correlation of one-third between milk amount and fat percentage.

The material in the present investigation offers considerable opportunity to study the mode of inheritance of milk characters. In brief, it may be stated that the variation in milk production and all

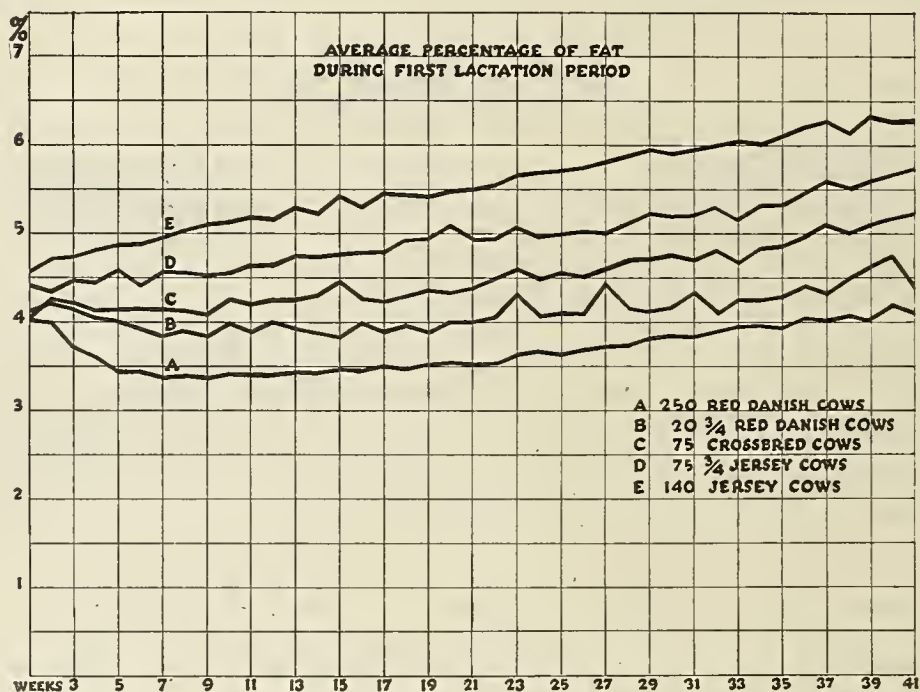


FIG. 2.—Average percentage of fat during first lactation period.

butterfat characters in crossbreeding experiments displays a typical picture of blending inheritance, the crossbreds being intermediate in every respect and the back crosses again intermediate between the crossbreds and the original parental breed. There is no sign of the action of any single Mendelian factor, although, on the other hand, the general belief is that blending inheritance is the outcome of the action of multiple Mendelian factors. No significant increase in variability is to be noted in the back crosses, and a second hybrid generation has unfortunately not been reared. Such an F_2 might have given valuable material for elucidating the question of multiple factor activity.

Although recent years have seen an increasing interest in the principles involved in the breeding of domestic animals, and although considerable efforts have been directed toward a biological

understanding of milk secretion, especially in cattle, we are still just at the beginning of this line of research, which is fascinating in itself and promises results of scientific as well as practical importance.

Chairman HILL. The next paper is "Dairy animals in Italy," by A. Pirocchi, of Italy; as he is not present, his paper will be read at the end of the session. The next paper discusses cattle breeding and inbreeding in Australia. Mr. M. A. O'Callaghan, dairy expert of the Commonwealth of Australia, is the author.

CATTLE BREEDING AND INBREEDING.

M. A. O'CALLAGHAN, dairy expert of the Commonwealth, Melbourne, Australia.

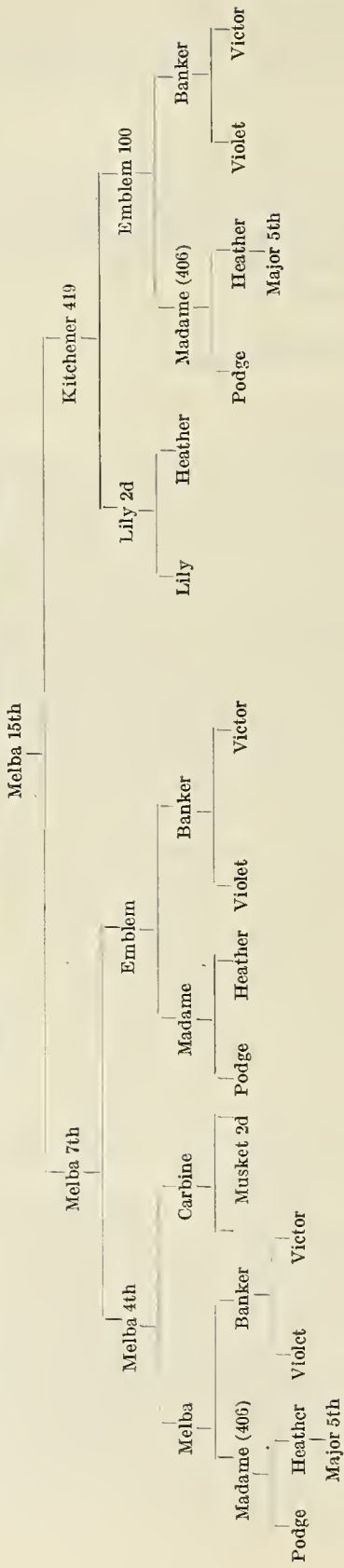
The Australian dairy Shorthorn has been evolved from Shorthorn cattle imported into Australia in the early settlement of that country. At that time the Shorthorn had not developed into the specialist in beef production that the beef section of the breed is to-day, and hence Australians had not a difficult job in improving the breed. Later, however, beef strains were imported and used with disastrous results in some herds—beef was produced where milk was wanted. This led to the introduction of Ayrshire blood to cross out the beef tendency. For 50 years now, however, no foreign blood has been introduced, and the breed is true to the best Shorthorn dairy type.

In dealing with the dairy production of the Shorthorn, the dairy historian of the future must give Australia very great prominence, for there—thanks to the efforts of many, but most notably to that great and scientific breeder, Mr. J. G. Cole, manager and studmaster of the Dorbolara estate, Gundagai, Australia—a branch of the Shorthorn has been evolved which takes a leading place in the competition of breeds. What has become known as the Melba family of Australian milking Shorthorns has consistently produced such good records that students of breeding must in their own interests study the lines of inbreeding carried on by Mr. Cole in his great work. A representative of the Melba family put up a record last year which temporarily at least placed her at the head of the cattle in the world as a butter producer; and another of the family was doing so well when I left Australia that I shall not be surprised if she puts up new figures in milk production for any breed.

All this family of Shorthorns are very inbred to two great bovines, viz, the cow known as Madame and the bull known as Banker. A study of the champion cow Melba 15th reveals the fact that in four generations there is very little but Madame and Banker blood.

Emblem was mated with his full sister's daughter (Melba 4th) and produced Melba 7th, who yielded over 1,000 pounds butter (869 pounds fat) in 365 days. Melba 7th, daughter of Emblem, was mated with Kitchener, son of Emblem, grandson of Madame, and produced Melba 15th, a world's champion for butter production, all breeds.

Breeding of Melba 15th, a recent world's champion cow.



Melba 25th, daughter of Melba 15th, yielded, when 3 years old, 10,168 pounds milk, 416 pounds fat, in 273 days. She may yet exceed her mother's record. Her sire is Silvermine.



Thus, when Melba 15th, granddaughter of Melba 4th, was mated with a son of Melba 4th, she produced this great young cow Melba 25th.

MELBA 15TH BLOOD.

Let X represent Banker blood, and let Y represent Madame blood. Then Melba 15th blood is made up as follows:

Melba is XY.

Melba 4th is XY by Carbine.

Melba 7th is from Melba 4th (XY by Carbine) by Emblem (XY).

Melba 15th is from Melba 7th [(XY by Carbine) by XY] by Kitchener

$\left(XY \text{ by } \frac{Y}{2}\right)$.

Thus in four generations we have all XY blood with the exception of one diffusion by Carbine (who in turn was related to Madame or Y blood) and a half outcross through Lily 2d.

SOME RECORDS OF THE MELBA FAMILY OF AUSTRALIAN MILKING SHORT-HORNS—THE MELBA-CARBINE LINE.

Madame (head female of line), when 16 years of age, tested officially 9,183 pounds milk, yielding 357 pounds fat, in 365 days, in one lactation. She was not tested earlier because official testing was not in practice earlier.

Melba (Banker-Madame) was never tested, as she died before official testing began.

Melba 4th (Carbine-Melba), when 11 years old, tested equal to 11,763 pounds milk, 498 pounds fat, in 273 days.

Melba 7th (Emblem-Melba 4th), at 6 years, yielded 17,364 pounds milk containing 869 pounds fat in 365 days.

Melba 15th (Kitchener-Melba 7th), at 6 years, gave 29,432 pounds milk containing 1,316 pounds fat in 365 days in one lactation.

Melba 25th (Silvermine-Melba 15th), at 3 years, yielded 10,168 pounds milk, containing 416 pounds fat, in 273 days.

In this line of the Melba family it is seen there are six generations of remarkable producers. From the second generation they are very closely inbred, mainly to Madame.

Melba 11th (Union Jack-Melba 7th), when 7 years old, yielded 13,057 pounds of milk, containing 568 pounds of fat, in 273 days. This cow is, it will be noted, from the same cow as Melba 15th. As Melba 7th and Union Jack are both by Emblem, this is a great concentration of Emblem, or original Melba 1st, blood.

Melba 29th (Kitchener-Melba 11th), at 3 years, gave 11,826 pounds milk containing 500 pounds fat, in 273 days, thus beating her very close relation Melba 25th at the same age.

Limelight: From this line, viz, Melba 7th, has also sprung the fine bull, by name Limelight, an animal of great constitution and showing no evidence of any weakness through inbreeding. He was awarded champion prize on inspection at the last Royal Show in Sydney, Australia.

THE MELBA-MUSKET 2D LINE.

Melba 3d (Musket 2d-Melba), when 8 years old, produced 13,818 pounds milk, containing 500 pounds fat, in 273 days.

Melba 16th (Emblem-Melba 3d, a mating of uncle and niece), at 4 years of age, produced 10,996 pounds milk, containing 477 pounds fat, in 273 days.

Melba 8th (King Arthur-Melba 3d's daughter) produced 11,295 pounds milk, containing 440 pounds fat, in 273 days, on pasture food only, when she was but a 3-year-old.

Melba 10th (Cameo-Melba 8th) produced 11,773 pounds milk, containing 504 pounds fat, in 273 days, when 4 years old.

Melba 17th (Kitchener-Melba 8th), now under test, had produced 16,695 pounds milk, containing 624 pounds fat, in 183 days up to June last. In this cow we have the result of mating a grandson of Banker and Madame with a great-great-great-grandaughter of the same two bovines.

Melba 15th is not the only inbred cow of note. There are several others, as may be gathered from the records of milking and breeding given herewith. What is particularly remarkable is the great constitution of this very inbred family. Banker was a great sire, and yet when exhibited in 1898 at Sydney Royal Show he was not placed, showing how poor indication to real worth is exhibition merit. I was personally of the opinion that this bull should have been placed, and the following month in the New South Wales Government Gazette I said as much, and gave a good picture of the beast. His son Emblem resembles greatly the cow Madame; and Kitchener (son of Emblem) also throws to Madame, as well he might, seeing that Lily 2d is a half sister to Madame. Kitchener, now a wonderful sire, is thus the progeny of a bull mated with his mother's half sister. Special attention is drawn to Melba 29th, a daughter of Kitchener when mated with his sire's granddaughter on both male and female sides. This young cow is indeed a wonderful concentration of Emblem or Banker-Madame blood. I feel sure that students of breeding could put in a whole week in a study of these pedigrees and records and be much enlightened thereby, and I feel that the breeder of this family of Shorthorn dairy cattle has done a work of great international importance.

Mr. O. ERF (Ohio State University). Do we understand that this is a purebred Shorthorn?

Mr. O'CALLAGHAN. To answer that question one must define the word purebred. There is no such thing as a purebred race of cattle. It depends on the number of generations necessary to produce purebred. Our animals descended from the English Shorthorns, introduced 75 years or 80 years ago. An outcross of Ayrshire was brought in 40 years ago, and in some families, it is said, was used but little. The breed has descended, without going back to beef. Unfortunately, as I pointed out, England made the mistake of paying attention to the pedigree side for beef purposes without paying attention to the milk purposes.

Chairman HILL. If there are no further questions to be asked on this paper, we will take up the questions and discussion of the other papers. Are there any questions on Major Buxton's paper?

Major BUXTON. I may add that no dairy Shorthorn is taken in to compete for prizes unless it gives 30 pounds of milk at a morning milking, the udder having been drained at the 6 o'clock milking on the previous evening.

Chairman HILL. The chairman should not take any part in the discussion, but he must answer a question Major Buxton brought up in his paper—the question as to why dairy Shorthorns had not been included in the National Dairy Show here. It is very easily answered. The dairy show association has adopted the rule that it will accept any breed that will announce itself as a dairy breed. The dairy Shorthorn people in this country will not do that; they announce themselves a dual-purpose breed.

Are there any other questions? Is there any discussion?

This completes our program for the morning. The papers of those authors who were not present, will be read by title.

(Adjournment.)

(Papers read by title):

MILK YIELDS AND ASSOCIATED FACTORS AS SHOWN BY THE SCOTTISH MILK RECORDS ASSOCIATION.

J. F. TOCHER, Ph. D., lecturer on statistics, University of Aberdeen, and consulting chemist to the Highland and Agricultural Society of Scotland.

I. MILK RECORDING IN SCOTLAND.

Systematic milk recording began in Scotland in the year 1903 and has been carried on continuously ever since. Up to the end of 1921 the milk yield and other particulars of 275,814 cows had been recorded and the results collated. Of this number, 2 per cent had been observed up to 1906. From 1907 to 1911, 16 per cent had been observed; 42 per cent were observed between 1912 and 1916; and 40 per cent were observed from 1917 to 1921. The following particulars were given for each cow.

TABLE 1.—*Individual cow record form.*

No. of society.				
Farm letter.	Breed.		No. of cow.	
Age.	Total yield in gallons.	Percentage of butterfat.	Yield in gallons at 1 per cent butterfat.	Weeks in milk.
Date of opening of record.			Date of closing of record.	
Date of calving.			Date of next calving.	

In addition to these particulars the writer has calculated the number of gallons per week and the number of pounds of butterfat per week given by each cow, from the records. The association has classified animals in an empirical manner into six classes as follows:

GOOD.

- I. Cows yielding over 2,500 gallons calculated as containing 1 per cent of butterfat.
- II. Heifers yielding over 2,000 gallons calculated as containing 1 per cent of butterfat.

BAD.

- III. Cows yielding under 1,660 gallons calculated as containing 1 per cent of butterfat.
- IV. Heifers yielding under 1,330 gallons calculated as containing 1 per cent of butterfat.

INTERMEDIATE.

- V. Cows yielding between 1,660 and 2,500 gallons calculated as containing 1 per cent of butterfat.
- VI. Heifers yielding between 1,330 and 2,000 gallons calculated as containing 1 per cent of butterfat.

The total yield of milk for a lactation period is an estimate made by the association, each cow being tested only at intervals ranging from 14 to 28 days. The yield of milk and the percentage of butterfat yielded by each cow in the interval were assumed to be those given on the date of the previous test. The unit employed in the comparison of milk yields of various qualities (that is, of various percentages of butterfat) was that which reckoned the yields in terms of gallons of milk containing 1 per cent of butterfat. This really amounts to recording the total amount of butterfat yielded by each cow during the specified interval, the yield being based upon one determination of butterfat and one determination of yield of milk during that interval. The milk was weighed and recorded in pounds, and in the records the term "gallon" is applied to the weight of 10 pounds of milk, and has therefore a special meaning, and is not really the usual gallon measure.

As an example of recording, suppose 30 pounds was the yield of milk from one cow on a particular date, and that this cow was again

tested after an interval of 14 days. Suppose also that the milk from this cow was found to contain 3.5 per cent of butterfat; the recorder converted the 30 pounds of milk containing 3.5 per cent of butterfat into pounds of milk containing 1 per cent of butterfat; or, $30 \times 3.5 = 105$ pounds of milk of 1 per cent quality. The recorder then multiplied these 105 pounds of milk—one day's yield—by 14, and thus provided an estimate of the number of pounds of milk of 1 per cent quality likely to be obtained during the 14 days between the two tests; that is, $105 \times 14 = 1,470$ pounds of milk of 1 per cent quality in 14 days. This was repeated on every occasion a test was made, and at the end of the lactation period of the cow the total estimated yield of milk of 1 per cent quality was ascertained by summation. The average percentage of butterfat for each cow for the whole lactation period was found by the recorder by dividing the number of pounds of milk of 1 per cent quality by the total number of pounds of milk.

II. THE RECORDS OF 1912.

(1) *An analysis of the records* for the year 1912 was carried out on 6,648 cows in order to show the number of calvings during each month of the year and to determine what variations took place in yield and average percentage of butterfat according to the month of calving. Table 2 shows the percentage of cows calving in the various months of the year, with the average yield in gallons and the average percentage of butterfat. The coefficient of variation is also given for the purpose of showing for yield the months giving the greatest variations in individual yield.

TABLE 2.—*Date of calving and production of milk. Records for 1912.*

Month.	Per-centage of cows.	Average yield of milk.	Degree of variation of yield compared with each mean as 100.
		Gallons.	
January.....	9.66	726	22.0
February.....	16.72	724	20.9
March.....	24.38	727	21.7
April.....	16.80	701	24.9
May.....	7.06	705	26.1
June.....	2.62	691	31.0
July.....	1.00	801	30.2
August.....	2.05	778	20.4
September.....	4.60	802	23.3
October.....	4.85	802	20.5
November.....	4.50	792	21.6
December.....	5.75	756	20.6

It will be seen that the greatest percentage of good cows calved in the month of March. The next highest percentages are the months of February and April, then follows January with about 10 per cent and May with about 7 per cent. Cows calving in the months of April, May, June, and July are more variable in milk yield when compared with cows calving in the months of December, January, February,

and March. The cows were accordingly grouped in four monthly periods. The results are given in Table 3.

TABLE 3.—Average values for cows calving in the three 4-month periods.

Character.	Group A Decem- ber to March.	Group B April to July.	Group C August to No- vember.
1. Number of cows.....	3,872	1,986	790
2. Yield of milk in gallons.....	658	614	737
3. Percentage of butterfat.....	3.72	3.77	3.75
4. Age of cow in years.....	5.87	5.65	4.91
5. Duration of lactation period, in weeks.....	37.86	34.54	42.41
6. Yield of milk, in gallons, for the average lactation period of 37.41 weeks..	650	666	650

From this table it is seen that the cows giving the highest average yield are those cows which calved within the four months from August to November, inclusive. The reason for this is obvious when the average duration of the lactation period of this group of cows is considered. On an average these cows were milked for 42.4 weeks, as against 37.9 weeks for the group calving within the four months December to March, inclusive, and 34.5 weeks for the cows calving within the four months April to July, inclusive. When the yield per week for each group is considered it is found that the average yield per week is practically the same for all three groups. The average percentage of butterfat is practically the same for the three groups. There is the greatest number of younger cows in the four months August to December, inclusive.

(2) *The results according to the association's three classes of cows.*—The association has divided the cows and heifers into three classes; good, bad, and intermediate. It is desirable therefore to know the average yield, the average percentage of butterfat, the average yield of butterfat, and the length of the lactation period for these three classes. Table 4 shows the results for good cows and good heifers.

TABLE 4.—Summary of good producers, 1912.

Character.	Good cows.	Good heifers.
Average yield of milk (gallons).....	804	649
Average yield of butterfat (pounds).....	300.6	251.7
Average percentage of butterfat.....	3.76	3.89
Average number of weeks in milk.....	39.9	41.4

The difference in average yield between good and intermediate cows is 236 gallons; and between intermediate and bad cows is 149 gallons. The difference in the total yield of butterfat during lactation period between good cows and intermediate cows is 94.9 pounds; and between intermediate cows and bad cows, 59.5 pounds. Good heifers have a significantly longer lactation period than good cows, but bad heifers have a significantly shorter lactation period than bad cows. Intermediate cows and heifers have practically the same average duration of lactation period. The difference in the

percentage of butterfat between good and intermediate cows is only about 0.13, and the corresponding difference for intermediate and bad cows is also 0.13. Good, intermediate, and bad heifers give practically the same average proportion of butterfat.

It does not appear from these results that the classification has any scientific basis and a reclassification is recommended.

(3) *The average yields of butterfat to be expected from cows of various ages and various durations of lactation period.*



FIG. 1.—Graphic representation of the relation between age, length of lactation period, and fat yield.

As the total yield of butterfat varies with age and also with the length of lactation period, it would be of practical importance to determine the average quantity of butterfat obtained from cows of various ages and for varying lactation periods. As a straight line does not represent either the relationship between age and yield of butterfat or between age and length of lactation period, an attempt was made to find an equation to a surface which would give for a particular age and a particular length of lactation period the average yield of butterfat to be expected. Owing to the nature of the

data, the direct calculation of the constants of such an equation was found to be unsatisfactory when the whole range of ages and lengths of lactation period was considered, although for a portion of the central part the agreement between the calculated and observed values was fairly satisfactory. A more satisfactory equation was obtained by first calculating two series of parabola and obtaining the required surface equation from a combination of these two. In the perspective view of the surface, Figure 1, the results are shown graphically.

III. THE RECORDS FOR 1920.

(1) *An analysis was made of the records for 1920, and altogether 21,450 returns were collated. Of these 5,320 were heifers and 16,130 were cows of all breeds. Ayrshires were predominant, there being 14,416 Ayrshire cows and 1,714 cows of British, Friesian, and Aberdeen-Angus breeds and Irish and Shorthorn crosses. In order to eliminate the effect of the duration of the lactation period, the yield of milk per week and the yield of butterfat per week were both calculated for each cow. The average yield of milk in gallons, the average age, the average percentage of butterfat, the average number of weeks in milk, the average total yield of butterfat in pounds, the average yield of butterfat per week, and the average yield of milk per week were all calculated for the 14,416 cows. The same characters were calculated for 4,912 cows whose lactation period was completed in 1920 and which had calved again within 60 weeks of the previous calving. Table 5 gives a summary of the results.*

TABLE 5.—Means of various characters, 1920.

Character.	Ayrshire cows— 1920 records.	
	Total of 14,416.	Total of 4,912.
1. Quantity of milk (gallons).....	667	697
2. Age of cow (years).....	6.40	6.22
3. Percentage of butterfat.....	3.82	3.81
4. Weeks in milk.....	34.93	37.45
5. Yield of butterfat (pounds).....	254	266
6. Yield of milk per week (gallons).....	19.1	18.6
7. Yield of butterfat per week (pounds).....	7.3	7.1

The differences are obvious and easily explainable. The average lactation period of 37.45 weeks for 4,912 cows is the average completed lactation period for that group. Naturally the total average yield of butterfat in pounds is greater for this group—266 pounds as against 254 pounds for the 14,416 cows. The yield of milk per week for the 4,912 group is less than the yield of milk per week for the 14,416 group for the same reason. In a completed lactation period the average yield per week would be less than in an incomplete lactation period because of the gradual falling off of the yield of milk in the latter part of the lactation period.

(2) *The yield of milk is known to be closely associated with the age of the cow.*—The average mean yield of milk per week in gallons for 2 and 3 year old heifers was 15.9 gallons, while for 4-year-old heifers the yield was 16.9 gallons. Table 6 shows the mean yield in

gallons per week and the mean yield of butterfat per week for cows of the undernoted ages.

TABLE 6.—Yield of milk and butterfat, 1920.

Age in years.	Average yield of milk per week.	Average yield of butterfat per week.	Age in years.	Average yield of milk per week.	Average yield of butterfat per week.
	<i>Gallons.</i>	<i>Pounds.</i>		<i>Gallons.</i>	<i>Pounds.</i>
3.....	17.84	6.99	11.....	19.82	7.42
4.....	17.79	6.87	12.....	19.36	7.17
5.....	18.87	7.26	13.....	20.42	7.54
6.....	19.35	7.39	14.....	19.81	7.48
7.....	19.79	7.52	15.....	18.60	6.95
8.....	20.10	7.60	16.....	18.58	6.97
9.....	19.91	7.50	17.....	18.80	6.91
10.....	19.90	7.47	18.....	19.25	6.94

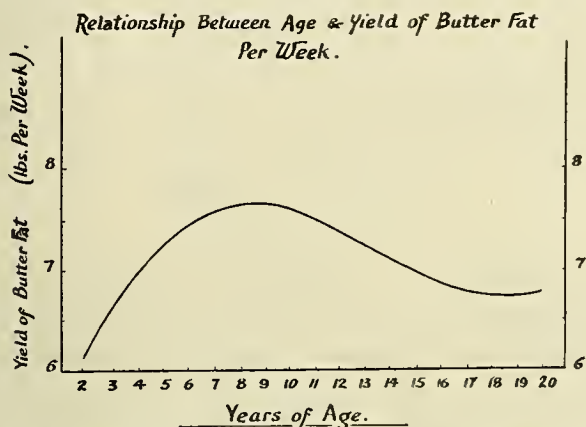


FIG. 2.—Relation of age to weekly butterfat production.

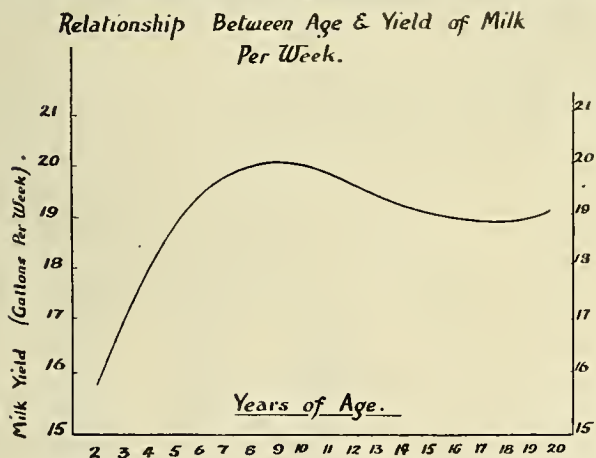


FIG. 3.—Relation of age to weekly milk production.

The laws connecting mean yield of milk per week and mean yield of butterfat per week with age have been determined. It has been found that cubic curves fitted by the method of moments give the best statistical description of the relationship between yield and age. The foregoing diagrams (Figs. 2 and 3) show the curves fitting best to the observations.

As seen from Figure 3, the mean yield per week is about 16 gallons for 2-year-old heifers and gradually rises until the mean yield is about 20 gallons for cows aged 8, 9, and 10 years, after which the mean yield falls with age until the age of 17 years is reached, when there is a gradual rise up to 20 years of age. The reason for this rise has been found to be due to the retention of specially good milkers by dairymen. There is a gradual elimination of the poorer cows after 9 or 10 years of age which retards the fall in the average yield and finally checks it altogether. It will be noted that the number of specially selected cows retained after 15 years of age, 0.26 per cent, is very small.

Inspection of Figure 2 reveals the fact that the mean yield of butterfat per week is about 6¼ pounds for 2-year-olds. The mean yield of butterfat per week rises until about 8 years of age, reaches a maximum at 8, 9, and 10 years, and again gradually falls until about 17 years of age. A very slight rise occurs after that age. This result is to be expected from our knowledge of the relationship of yield of milk with age.

The goodness of fit of these curves was tested by Pearson's well known X² method. In this case

$$X^2 = S \left\{ \frac{n_p(m_p - \overline{m}_p)^2}{\sigma^2 n_p} \right\}$$

where *n_p* is the frequency in a particular age group, σ*n_p* is the corresponding standard deviation, and *m_p* and *m_p* are respectively the observed and calculated average values of the character for the age group.

Table 7 shows the results. It is seen that the fits are not very good, and this is due to the fact that in the majority of cases the cows had not completed their lactation periods and to the fact that heifers are included along with cows. If heifers are excluded fairly good fits are obtained.

TABLE 7.—Records for 1920, of 15,106 Ayrshire cows (including 696 2-year-old heifers); relationship of various characters with age and curves fitted.

Age (years).	Frequency.	Yield of milk per week.		Yield of butterfat per week.	
		Observed.	Calculated.	Observed.	Calculated.
		Gallons.	Gallons.	Pounds.	Pounds.
2.....	696	15.93	15.86	6.30	6.15
3.....	391	17.82	17.07	6.99	6.63
4.....	3,179	17.80	18.04	6.87	7.01
5.....	2,818	18.87	18.78	7.26	7.29
6.....	2,231	19.35	19.33	7.39	7.48
7.....	1,808	19.79	19.71	7.52	7.60
8.....	1,351	20.09	19.93	7.60	7.65
9.....	937	19.91	20.03	7.50	7.64
10.....	728	19.90	20.01	7.47	7.59
11.....	457	19.83	19.92	7.42	7.50
12.....	266	19.36	19.76	7.17	7.38
13.....	114	20.42	19.57	7.54	7.25
14.....	59	19.79	19.36	7.48	7.12
15.....	31	18.64	19.15	6.95	6.98
16.....	18	18.58	18.98	6.97	6.87
17.....	11	18.80	18.86	6.91	6.77
18.....	8	19.25	18.82	6.94	6.72
19.....	2	20.75	18.87	8.25	6.71
20.....	1	19.25	19.05	6.00	6.75
15,106		Age, 2-18 years, inclusive (19 and 20 left out on account of small numbers). X ² =44.09 P = 0.0008		Age, 2-18 years, inclusive (19 and 20 left out). X ² =23.63 P = 0.1304	

Attention was then concentrated on the mean quantity of butterfat per week and other mean values of the 4,912 cows. Table 8 shows results for cows from 3 to 18 years of age.

TABLE 8.—Records for 1920, of 4,912 Ayrshire cows; relationship of various characters with age and curves fitted.

Age (years).	Fre- quency.	Yield of milk per week.		Yield of butterfat per week.		Percentage of butterfat.		Weeks in milk.	
		Ob- served.	Calcu- lated.	Ob- served.	Calcu- lated.	Ob- served.	Calcu- lated.	Ob- served.	Calcu- lated.
		Gallons.	Gallons.	Pounds.	Pounds.				
3.....	112	16.88	16.41	6.51	6.36	3.859	3.884	37.68	37.54
4.....	1,129	17.36	17.46	6.69	6.73	3.854	3.857	37.54	37.51
5.....	1,047	18.32	18.28	7.02	7.00	3.849	3.833	37.57	37.48
6.....	812	18.94	18.90	7.24	7.20	3.818	3.812	37.26	37.45
7.....	636	19.20	19.34	7.26	7.33	3.770	3.793	37.35	37.43
8.....	419	19.95	19.61	7.52	7.40	3.765	3.777	37.56	37.40
9.....	276	19.39	19.74	7.29	7.42	3.774	3.764	37.18	37.37
10.....	223	19.83	19.74	7.39	7.40	3.737	3.754	37.38	37.34
11.....	122	19.80	19.65	7.45	7.35	3.764	3.746	37.19	37.34
12.....	75	19.35	19.48	7.28	7.28	3.765	3.742	37.84	37.29
13.....	32	18.94	19.25	7.16	7.19	3.773	3.740	37.72	37.26
14.....	15	18.69	18.98	7.08	7.11	3.775	3.741	37.00	37.23
15.....	7	19.43	18.69	7.18	7.02	3.696	3.744	32.43	37.20
16.....	2	19.50	18.41	7.50	6.95	4.000	3.750	33.50	37.18
17.....	4	18.00	18.15	6.50	6.91	3.625	3.759	43.25	37.15
18.....	1	19.00	17.93	7.75	6.90	4.125	3.771	35.00	37.12
		$X^2=14.22$ $P = 0.5821$		$X^2=13.16$ $P = 0.6606$		$X^2=16.60$ $P = 0.4124$		$X^2=10.69$ $P = 0.8269$	

These results show that there is good agreement between observation and theory for this group of cows. In 58 cases out of every 100

1920 Records - Ayrshire Cows - Total 4912.
Parabola Fitted to whole data.

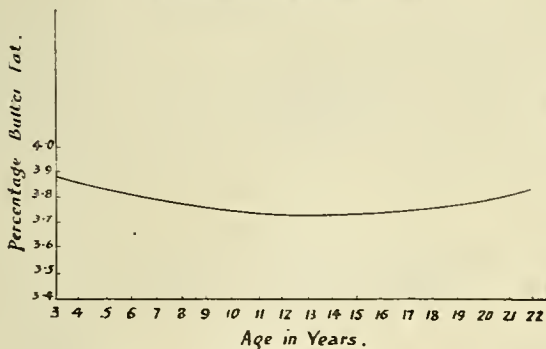


FIG. 4.—Relation of age to percentage of butterfat in the milk.

samples, one would get worse fits in the "yield of milk" curve: in 66 cases out of 100, worse fits would be obtained in the "yield of butterfat" curve. It is thus clear that cubic curves fitted by the method of moments adequately describe the observations of the 4,912 cows with complete lactation periods, with regard to these characters. In the case of percentage of butterfat, a parabola was fitted which it will be seen gives a good description of the data, while for weeks in milk a straight line was found to give a good fit. In 41 cases out of 100 one would get a worse fit in the "percentage of butterfat" curve, while for weeks in milk the fit would be worse in 83 cases out of 100. Figures 4, 5, 6, and 7 show these results in graphic form.

1920 Records - Ayrshire Cows - Total 4912.
Cubic fitted to whole data.

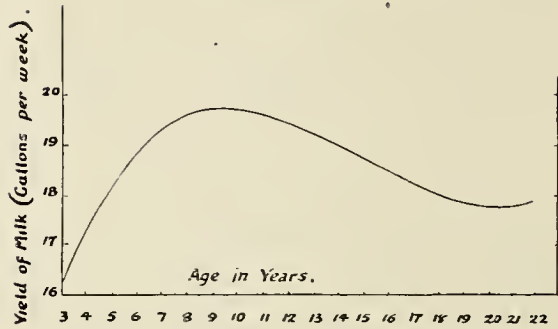


FIG. 5.—Relation of age to milk yield.

1920 Records - Ayrshire Cows - Total 4912.
Cubic Fitted, 3 - 18 Years.

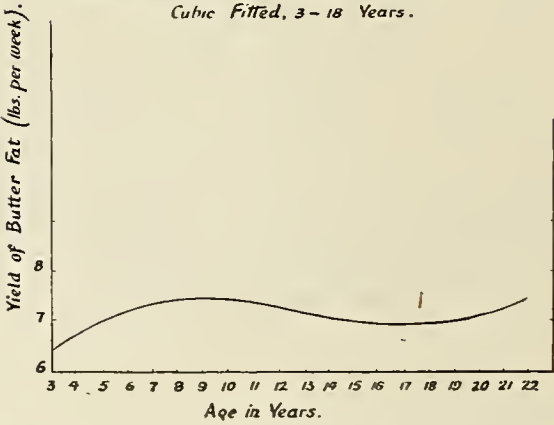


FIG. 6.—Relation of age to yield of butterfat.

1920 Records - Ayrshire Cows - Total 4912.
Straight Line Fitted, 3 - 18 Years.

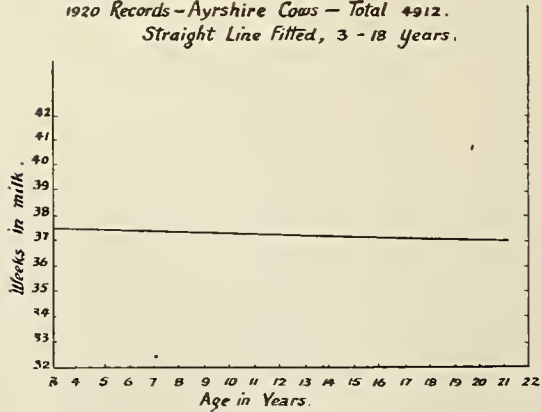


FIG. 7.—Relation of age to length of lactation period.

IV. THE VARIATION IN MILK YIELD DURING A LACTATION PERIOD.

As already stated, the Scottish Milk Records Association determine at stated intervals the yield of milk per day for each cow. It is possible therefore to note the change in yield of milk during a lactation period. These records can be compared with the results of private daily tests.

TABLE 9.—Mean yield for each fortnight.

Fortnightly interval.	Actual yield, private records.	Estimated yield, association records.	Difference. association over private records.
	Gallons.	Gallons.	
Second.....	55.04	54.85	—0.19
Third.....	58.40	60.28	+1.88
Fourth.....	57.53	57.40	— .13
Fifth.....	54.25	54.36	+ .11
Sixth.....	51.09	51.66	+ .57
Seventh.....	47.72	48.48	+ .76
Eighth.....	45.69	46.37	+ .68
Ninth.....	44.03	44.35	+ .32
Tenth.....	39.08	40.33	+1.25
Eleventh.....	35.25	35.75	+ .50
Twelfth.....	32.17	32.39	+ .22
Thirteenth.....	31.02	31.62	+ .60
Fourteenth.....	29.63	30.20	+ .57
Fifteenth.....	27.87	28.23	+ .36
Sixteenth.....	25.62	25.94	+ .32
Seventeenth.....	23.25	23.38	+ .13
Eighteenth.....	22.50	22.75	+ .25
Nineteenth.....	20.41	21.05	+ .64
Twentieth.....	18.04	18.38	+ .34
Twenty-first.....	15.52	16.09	+ .57
Twenty-second.....	17.16	17.48	+ .32

In studying the variations in yield of a single cow during a lactation period, it is clear that a cow would give a record which would vary in a definite manner according to the month of calving. One would not expect, however, that a cow calving, say, in October, would give in successive fortnights yields of the same amounts as a cow calving, say, in April. There is usually an increase in milk yield

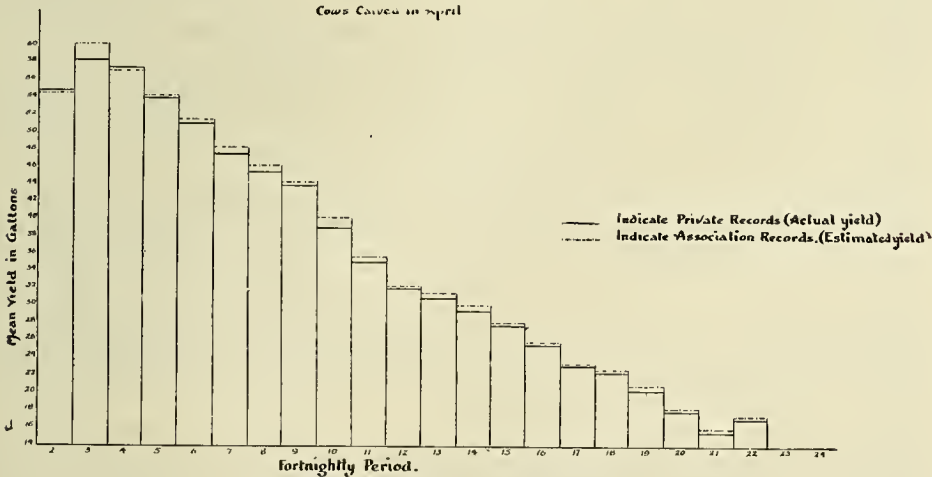


FIG. 8.—Estimated and actual fortnightly yields.

when cows are put on grass, and the cows might be put on grass early in the lactation period, or in the middle, or toward the end of the lactation period. In order, therefore, to make a proper comparison between the private and association records of average yield for each fortnight during a lactation period, 35 cows were chosen out of a total of 107 because they had all calved in the same month, namely, April. Variations during the lactation period would thus be similar in character. For example, they would all be put on grass at the same time. Table 9 shows the averages from the second fortnight onwards, the first and last tests being omitted as requiring special study by themselves. It is clear that, as far as these fortnightly periods are concerned, the association prediction is a good one. Considerable deviations from the observed values occur in the association's estimates for the first period. The writer has under consideration what method would best describe the yield for the first fortnight from one or two tests.

The estimated and actual fortnightly yields are also shown graphically in Figure 8, on page 1415.

LES ANIMAUX LAITIÈRES EN ITALIE.

ANTONY PIROCCHI, directeur de l'Institut Zootechnique de l'Ecole Royale Supérieure d'Agriculture de Milan, Italie.

Le 19 mars 1908 l'Italie possédait les animaux suivants appartenant à des espèces productrices de lait: Race bovine (taureaux), 6,198,861; race bovine (buffles), 19,366; race ovine (béliers), 11,162,926; race ovine (boucs), 2,714,878.

En partant de ces chiffres M. Besana¹ procéda à la détermination approximative des femelles laitières, selon chacune des quatre espèces d'animaux ci-dessus.

Pour la race bovine M. Besana établit le 55 pour cent de ces femelles sur le total des animaux; pour les buffles il fixa le 51 pour cent; pour l'espèce ovine le 70 pour cent; pour l'espèce caprine le 55 pour cent.

En se basant sur ces pour cent M. Besana calcula les femelles laitières dans les chiffres suivants: Vaches, 3,400,000; femelles du buffle, 10,000; brebis, 7,800,000; chèvres, 1,500,000.

Afin de déterminer la quantité moyenne du lait produit annuellement par ce bétail, il fallait aussi fixer les chiffres relatifs à la production moyenne du lait de chaque femelle traite.

Ce n'est pas tout à fait facile de pouvoir établir cette moyenne à cause de la grande différence de l'alimentation et de l'aptitude laitière de ces races, de l'inégalité des conditions du climat où elles vivent, etc.

Tandis que dans la basse Lombardie on peut retenir en effet que la production du lait est en moyenne d'environ 30 hectolitres par vache, dans la zone alpine elle descend à moins de la moitié, et à un quart environ chez les troupeaux à l'état sauvage au centre et au midi de l'Italie et de la Sardaigne.

¹ C. Besana. Sur l'état actuel de l'industrie du lait en Italie. Bull. mens. de renseign. agrair. Rome. Typographie de l'Institut International d'Agriculture, 1914.

M. Besana crut alors d'être près de la vérité, estimant en 12 hectolitres par an le rendement moyen de chaque vache, mais il ne retint pas le devoir tout simplement de multiplier ces chiffres par 3,400,000 vaches nommées ci-dessus. De celles-ci il enleva 800,000 vaches à s'exclure du compte, n'ayant pas été traites, ou ayant été traites pendant très peu de temps.

Ainsi, sur la base de 12 hectolitres de lait par an et de 2,600,000 vaches vraiment traites, M. Besana arriva à établir, toujours approximativement bien entendu, que le lait produit par les vaches laitières en 1908 était de 31,200,000 hectolitres.

Pour calculer la production du lait de brebis il ne faut pas oublier qu'en Sardaigne la quantité moyenne du lait de chaque brebis, le lait consommé par l'agneau déduit, est environ de 100 litres par an, tandis qu'en Italie continentale cette quantité est de 40 litres. M. Besana prit pour base le chiffre de 70 litres, lequel multiplié par 7,800,000 brebis fait 5,460,000 hectolitres.

La production du lait de chèvre fut établie en 1,500,000 hectolitres, calculant sur 100 litres par chaque chèvre le lait consommé par le chevreau déduit.

La production du lait de buffle fut enfin déterminée en 45,000 hectolitres, sur la base d'un produit de 4.5 hectolitres par tête.

De sorte que en 1908 la quantité annuelle du lait produit en Italie fut calculée par M. Besana: Lait de vache, 31,200,000 hectolitres; lait de buffle, 45,000 hectolitres; lait de brebis, 5,460,000 hectolitres; lait de chèvre, 1,500,000 hectolitres; total, 38,205,000 hectolitres.

Probablement ce total en 1908 était inférieur à la vérité; ce qui devait être encore davantage à la veille de la grande guerre, car, selon les notices dont on doit faire cas, recueillies en 1914, la consistance numérique des bœufs résulta, pendant cette année, à environ le 7 pour cent supérieure à celle qui existait en 1908.

Mais après l'an 1914 des causes survinrent qui bouleversèrent l'économie agricole italienne; la guerre, qui imposa un grand abatage de bétail de race bovine—le bétail laitier ne fut pas épargné non plus—et de nombreux achats en gros de fourrages; l'invasion de florissantes provinces de la Vénétie de la part de notre ennemi et la conséquente destruction de leur patrimoine zootechnique; l'épizootie aphtheuse de l'an 1917-18; les restrictions imposées pendant la période guerrière à l'industrie et au commerce des produits de lait; enfin, la dévaluation de la lire et les conséquents renchérissements des fourrages, du bétail, etc.

Tout cela arrêta le mouvement merveilleux et ascensionnel qui, depuis 50 ans, se vérifiait dans l'industrie zootechnique de l'Italie.

A présent on peut affirmer cependant que, après le grand effort que l'Italie a accompli dans la grande guerre, on voit déjà cicatriser les graves blessures apportées à la zootechnie de notre patrie.

Le dernier recensement du bétail, exécuté le 7 avril 1918, montra la vérité de cette assertion.

En effet le numéro des animaux de race bovine enregistrés en 1918 résulta de 6,239,341, c'est-à-dire 40,880 de plus de ceux enregistrés en 1908.

Ces augmentations furent spécialement remarquées en Lombardie, 1,215,695 animaux contre 1,085,043 en 1908, c'est-à-dire 130,652 animaux de plus. Dans l'Emilie, 1,082,089 animaux contre 961,217 en 1908, c'est-à-dire 120,872 de plus. En Piémont, 1,008,143 ani-

maux contre 961,437 en 1908, c'est-à-dire 46,706 de plus. Il faut encore remarquer que ces augmentations se vérifièrent surtout dans les régions où la production zootechnique est adressée principalement à la production du lait.

En outre, tandis que les animaux de race bovine et ceux de race chevaline se ressentirent de l'action dévastatrice de la guerre, la plupart des brebis en furent dispensées et leur élevage fut favorisé, au contraire, par ces circonstances principales: les prix des laines qui, en général, furent assez élevés et rémunérateurs; le prix de la chaire d'agneau qui devint le triple et même le quadruple pendant la guerre; le fromage de brebis qui, déjà assez répandu, fut produit en des conditions d'un sensible profit, la plupart des frais de production n'ayant pas subi la hausse dans les mêmes rapports des prix de ventes. Ce furent enfin ces circonstances qui conseillèrent beaucoup d'agriculteurs de l'Italie centrale et méridionale et aussi ceux des grandes îles à produire et à élever un plus grand nombre de brebis.

Cela fut encore confirmé par le recensement qu'on a rappelé tout à l'heure et qui dit que contre 11,162,926 animaux de race ovine enregistrés en 1908 il y en avait 11,753,510 en 1918, c'est-à-dire, 590,984 de plus.

On remarqua ces augmentations et d'une manière toute particulière dans le Latium, dans les Abruzzes, dans la Pouille, en Basilicate, en Sicile et en Sardaigne.

On peut dire de même pour les chèvres; dans le midi de l'Italie où, pendant la guerre, fut importé un nombre mineur de vaches pour la production du lait à la consommation publique, on a bien compris la nécessité d'élever un plus grand nombre de ces bêtes laitières, dont les prix élevés, ainsi que ceux du lait, ont été plus que rémunérateurs.

Et, en effet, au mois d'avril 1918 furent enregistrés 3,082,558 animaux de race caprine contre 2,714,878 en 1918, avec une augmentation de 367,680 animaux.

On peut conclure alors que, ces conditions de fait données, ce n'est pas exagérée l'opinion de ceux selon lesquels actuellement, avec la reprise de l'accroissement chez les laitières, la production annuelle de lait en Italie, sinon supérieure, est tout près de 40,000,000 d'hectolitres.²

ESPÈCES ET RACES LAITIÈRES EN RAPPORT À LEUR IMPORTANCE POUR L'ITALIE.

Tandis que dans les régions entre les Alpes et la vallée du Pô la fromagerie est spécialement alimentée avec le lait de vache, chez les autres régions c'est la brebis qui est la plus grande productrice de lait.

Les conditions du climat de la zone des Alpes où l'on rencontre de grandes vallées et de vastes pâturages à des hauteurs plus ou moins remarquables, rendent cette zone particulièrement propre à la spécialisation des animaux de race bovine vers la production du lait.

Dans les vallées du haut Piémont ces animaux appartiennent aux races des montagnes de Valsesie, de Suse, de l'Ossola, d'Oropa, etc.

² G. Fascetti. Réorganisation de l'expérimentation et de l'enseignement de l'industrie laitière en Italie. Lodi, 1922.

Ces races, à vrai dire, sont constituées par des groupes d'animaux de race bovine plus ou moins nombreux, mais qui n'ont pas l'uniformité de caractères nécessaires pour arriver à la dignité d'une race.

Ces animaux étant le résultat d'un croisement entre la race jurassique et la race brune des Alpes du Sanson, leurs caractères varient, en effet, selon la prépondérance de celle-là ou de cette dernière.

Dans les vallées des Alpes lombardes on rencontre au contraire la race brune alpine, surtout dans les Provinces de Sondrio, de Come, de Bergame, et de Brescia, en différents degrés de pureté.

Mais c'est surtout dans la fertile plaine du Pô où l'industrie des animaux de race bovine productrice de lait atteint son plus haut degré d'intensité et dans quelques endroits même de perfection.

C'est ici que le climat favorable, la nature et la fertilité du terrain, l'irrigation savamment réglée ont porté la culture des prés à son plus haut degré de développement, en rendant cette zone l'une des plus renommées du monde. La production fourragère des marcites peut permettre huit ou neuf et même dix tailles et arriver à 1,200 quintaux d'herbe par hectare, depuis mars jusqu'à octobre, et peut même dépasser cette production.

Les fermes destinées à l'utilisation de la vache à lait y sont aussi très nombreuses.

Dans la basse Lombardie, qui est la première région de laiterie de l'Italie, le type le plus commun de ferme à l'extension moyenne est de 70-80 hectares avec une rotation agraire telle à pouvoir destiner deux tiers à pré et un tiers de la surface à céréales; sur chaque ferme on nourrit 70-80 vaches appartenant surtout à la race brune alpine et dans un nombre plus petit à la race hollandaise, ou bien de vaches nées de l'union de ces races avec des vaches indigènes.

Même dans d'autres régions, quoiqu'on n'y rencontre pas les favorables conditions du milieu que l'on rencontre en Lombardie, le bétail à lait est aussi assez productif.

Nous voyons cela dans l'Emilie, surtout dans les Provinces de Parma et de Reggio, où il y a des fermes avec des terrains irrigables et des races estimables, telles que la race de Reggio, la race simmental, et la race brune des Alpes.

Mais, outre que sur ces zones, on trouve encore la vache à lait ça et là et un peu par tout le reste de l'Italie, en stabulation permanente, près d'importants endroits habités et spécialement pour l'approvisionnement du lait pour la population humaine; ou bien on la trouve à l'état sauvage ou à demi-sauvage, comme il arrive dans la Maremme Toscane, dans l'Agro Romano, dans la Campagne, et, en général, dans les régions méridionales de notre péninsule, en Sicile et en Sardaigne, etc.

À côté des races schwytz, hollandaise et simmental qu'on y rencontre, on doit encore mentionner la race noire de Pise, qui, selon que l'on dit, a été obtenue par croisement entre la race schwytz et la race hollandaise.

Cette race est bien répandue dans toute la Toscane, spécialement dans les campagnes pisanes.

De plus, on trouve la race bretonne à Alfedena (Aquila); la race de Modica en Sicile et les métises schwytz-sardes, en Sardaigne, etc.

Parmi les races italiennes et étrangères la race alpine brune reproduite dans sa pureté ou croisée à des races locales a été jusqu'ici la triomphatrice, grâce à sa grande facilité à s'acclimater dans les

conditions les plus variées et à son estimable aptitude à la production du lait.

C'est à cause de tout cela que cette race est répandue désormais dans toute l'Italie.

La race simmental a eu, au contraire, une diffusion moins vaste. Avant la guerre, elle était bien accueillie dans le Frioul (Vénétie), puis elle s'est répandue, plus ou moins favorablement acceptée, dans une partie de la Lombardie et de l'Emilie, etc. Mais il est hors de doute qu'elle pourra aussi, dans sa qualité de race amélioratrice, se rendre utile dans ces zones où les meilleures conditions de milieu exigent des animaux de race bovine qui fournissent le lait en même temps que la chair.

Il y a enfin la race hollandaise qui, jusqu'à présent a eu une plus petite diffusion, mérite cependant d'être tenue avec la plus grande considération pour les zones où elle peut vraiment donner un plus grand profit, en comparaison d'autres races; par exemple, dans plusieurs endroits de la plaine lombarde, dont les prairies irrigables sont les plus belles et les plus productives que l'on connaisse, peuvent abondamment nourrir ces grandes vaches frisonnes.

Après la vache, ainsi qu'on l'a déjà dit, c'est la brebis qui a la plus grande importance pour la production du lait en Italie.

La brebis habite la région des Alpes, les pays autour de Bielle, Bergame, Bellune, etc.; on la trouve aussi dans les petites et dans les moyennes fermes de l'Italie centrale, où elle utilise les fourrages de rebut qu'on ne peut pas donner aux animaux de race bovine, et où elle pâit le long des fossés des routes, sur les dernières tailles des prés, etc.

A l'égard de l'économie agraire italienne la brebis a une grande importance le long de l'Apennin central et méridional, ainsi que dans les îles de la Sicile et de la Sardaigne.

C'est dans cette dernière que, avec la petite industrie stationnaire du fromage de brebis, depuis les temps les plus éloignés, a pris terrain la forme caractéristique de l'art pastorale "transumante" digne d'être mis en relief.

Chez différentes régions de l'Italie centrale et méridionale à présent et peut être aussi pendant plusieurs années, le milieu agraire climatique et hygiénique impose, on peut dire, cette industrie pastorale avec les mêmes caractères qu'elle présente depuis quelques siècles.

Tandis que nous avons l'Apennin, ce grand squelette montueux qui dans quelques lieux occupe plus de la moitié de la largeur de notre péninsule et qui avec ses rochers nus présente à des hauteurs différentes de vastes pâturages, tantôt plaines tantôt escarpées au sudest et à l'ouest de cette chaîne de montagnes, nous trouvons à perte de vue les plaines à pâturage de la Pouille, de la Campagne romaine et de la Maremme Toscane.

On rencontre d'analogues conditions en Sicile et en Sardaigne.

Comment doit-on utiliser les herbes de ces vastes territoires? L'expérience de plusieurs siècles nous a révélé, par leur climat rigoureux et par leur terrain nu et stérile, qu'il est assez difficile à une population nombreuse, sédentaire presque pendant toute l'année, de pouvoir vivre sur les montagnes.

Il en est de même à cause de certaines conditions climatiques hygiéniques encore plus graves dans les plaines du littoral de la mer tyrrhénienne et adriatique.

C'est pour cela que vers la fin du printemps, lorsque la bonne pâture de la plaine de la Pouille, du Latium et de la Tosca ne disparut, l'herbe alors est vite brûlée par le soleil; les bergers obligés aussi de s'en aller à cause de la fièvre paludienne, émigrent avec leurs troupeaux vers les montagnes pour y utiliser les herbes aromatiques, pendant la belle saison, revenant en automne aux plaines hospitalières.

Il est évident que ce système de pâturage est une nécessité absolue et que la brebis qui en est le pivot doit être considérée comme l'un des animaux les plus précieux.

En Piémont les brebis les plus répandues sont celle de Bielle; en Lombardie c'est la race de Bergame qui est digne d'être mis en relief.

Dans l'Emilie il y a des brebis sur l'origine desquelles on n'est pas du même avis. Il semble qu'elles dérivent du croisement de brebis indigènes et de brebis de race mérinos et celle de Bergame.

D'une plus grande importance par le nombre et par la qualité des animaux, ainsi que par la sécrétion laitière, ce sont les autres régions du centre et du midi d'Italie.

La race vissane et la race sopravissane sont répandues dans toute l'Italie centrale.

Elles sont ainsi appelées du nom des pays de Visso et de la région des Apennins qui est au-dessus et où il y a les meilleurs animaux.

C'est la race de Visso qui est la plus acceptée dans les Marches et l'Ombrie, tandis que dans le Latium et dans quelques endroits des Abruzzes prédomine la race sopravissane à la formation de laquelle ne furent pas étrangères la race mérinos de l'Espagne, la race gentille de la Pouille et celle de Rambouillet.

Une race nommée pagliarole vit aussi dans les Abruzzes.

Elle est ainsi appelée parce que, pendant la plupart de l'année, ses brebis se nourrissent des fourrages les plus ordinaires et quelquefois même de paille seulement.

La Pouille nourrit la race gentille de la Pouille, qu'il vaudrait mieux appeler la race des brebis mérinos de la Pouille.

En effet, et depuis longtemps, cette race a été améliorée par la race mérinos de l'Espagne à laquelle elle ressemble beaucoup.

On voit enfin que la race des brebis de la Sicile et de la Sardaigne se rapproche beaucoup de la race syrienne du Sanson.

À présent en Italie les conditions particulières économiques sont si favorables qu'elles devraient pousser les agriculteurs à rendre plus intensif l'élevage des brebis.

On peut réaliser cette intensité en destinant à la brebis tous les terrains de la montagne et de la plaine qui, par des causes tout à fait spéciales, ne sont pas propre au reboisement, ou à d'autres animaux, et qui peuvent être utilisés par la pâture des brebis.

Où bien, tout en gardant pour l'élevage des brebis la surface qu'elles occupent actuellement, ou la réduisant même aux lieux où l'agriculture intensive va s'avancer, augmentant le profit total de cet élevage par de convenables méthodes zootechniques parmi lesquelles une alimentation appropriée et un choix rationnel des animaux reproducteurs doivent occuper la première place.

À l'égard de ce choix, il ne faut pas oublier que le bélier de race mérinos a déjà donné lieu à des améliorations remarquables surtout dans le Latium et dans la Pouille. Des reproducteurs de races anglaises (Lincoln, Southdown, Cotswold, etc.) ont été aussi, dans quelques

endroits, employés au but d'améliorer l'aptitude à la chair, mais avec peu de résultats.

Parmi les races étrangères conseillées pour augmenter la production du lait, on doit nommer la race frisonne qui, tout en donnant un résultat négatif, a été expérimentée récemment à l'Institut du Latium.³ Mais encore plus que le croisement avec des races étrangères, il semble aujourd'hui plus convenable de soigner la sélection méthodique des différentes races indigènes parmi lesquelles il y a une assez grande aptitude laitière.

La chèvre est surtout assez répandue dans les îles de la Sardaigne et de la Sicile et dans les régions méridionales de notre péninsule. Elle est encore répandue dans les zones montueuses du Piémont, de la Lombardie, de la Toscane, des Marches et de l'Ombrie, où il y a des pâtures qui, par leur ubiquité et par leur flore, sont très peu utilisées par les autres animaux et où la propriété foncière est fractionnée. Cet animal vagabond est élevé presque partout à l'état sauvage ou à demi-sauvage.

Pendant la guerre la chèvre s'est répandue encore plus que dans le passé. A sa diffusion s'oppose la lutte—pas toujours justifiée—que les gardes-forestiers lui ont adressée, la considérant la cause principale de l'état où sont réduites nos montagnes, tandis que la plus grande vérité c'est que le pire ennemi du bois a été l'homme.

Les races caprines italiennes appartiennent à deux branches O. C. européenne et O. C. africaine. Au nord et au centre d'Italie prévaut la race alpine, au midi et dans les îles, avec celle-ci, on trouve surtout en Sicile beaucoup de représentants de la race maltaise.

Exception faite pour quelques tentatives d'amélioration moyennant le croisement avec des chèvres de Saanen, du Thibet etc., la reproduction caprine a toujours été pratiquée par une sélection peu scientifique.

Si à cette dernière on substitue la sélection méthodique, morphologique et physiologique du bouc et de la chèvre, on pourrait certainement obtenir des résultats bien meilleurs.

En Italie il faut prendre en considération même le buffle dans la production du lait.

Il y a ce vaste territoire des Marais Pontins qui mesure 123,000 hectares de surface; malheureusement il y a d'autres terrains marécageux au midi (Campagne, Pouille, Basilicate) sur lesquels les buffles se sont révélés en comparaison des autres animaux plus productifs et plus résistants aux maladies. Il y en a qui croit qu'avec le progrès des assainissements des terrains marécageux les buffles doivent peu à peu diminuer leur nombre pour disparaître complètement de l'Italie.

Mais avant d'arriver à leur disparition, il faudra que beaucoup d'eau passe dans la nombreuse série de canaux à l'expurgation desquels les buffles sont assez utilement employés.

Je pense d'ailleurs que les agriculteurs, même après avoir terminé les assainissements de leurs terrains, peuvent continuer à tirer des avantages non indifférents de ce bétail en complétant son apprivoisement, le passant par degrés, de l'élevage sauvage ou à demi-sauvage, à celui de l'étable, en soignant son alimentation et en exaltant son aptitude à la sécrétion du lait, au moyen d'une gymnastique méthodique et fonctionnelle de la glande mammaire.

³ La race des brebis de la Frise orientale; résultat d'une épreuve à l'Institut Zootechnique du Latium. La clinique vétérinaire, Milan, N. 21 et 22, 1920.

[Abstract.]

DAIRY ANIMALS IN ITALY.

ANTONY PIROCCHI, director of the Institute of Animal Husbandry in the Royal Agricultural High School, Milan, Italy.

I. STATISTICAL NOTES AND CALCULATIONS OF ANNUAL MILK PRODUCTION.

The numbers of cows, buffaloes, sheep, and goats in Italy in 1908 are given, and calculations of milk production for that year. Probably a considerable increase took place before 1914, but war conditions and the epizootic of 1918 temporarily checked progress. The census of 1918, however, shows an increase over 1914, particularly in Lombardi, Emilia, and Piedmont, regions where animal husbandry is concerned principally with milk production. While the numbers of horses and cows were decreased by the war, sheep raising was encouraged by the high price of wool and mutton, and the production of sheep's milk cheeses became more profitable. The numbers of goats likewise have greatly increased.

II. DAIRY TYPES AND BREEDS ACCORDING TO THEIR IMPORTANCE FOR ITALY.

The author discusses in detail the breeds of cows raised in different districts of Italy, and the variations of climatic conditions and pasturage which favor the raising of each.

The conditions which make the raising of milk-producing sheep particularly profitable in various regions of Italy are explained, and the various breeds discussed, as well as means of improving milk production. Mention is also made of the various types of goats, though little scientific work has been done to develop them. The buffaloes in Italy are limited to the great marshy regions which are gradually being drained.

DAIRYING IN BRAZIL.

ALEIXO DE VASCONCELLOS, Ph. D., chief of dairy division, Ministry of Agriculture, Rio de Janeiro, Brazil.

Brazil is the largest country in South America, and the third largest in the whole world. Her great territorial expanse may be said to form one solid and undivided block, which measures 4,307 kilometers from north to south and 4,336 kilometers from east to west. Over this immense area flow the largest rivers of the world, and it contains huge mountain chains. The vegetation is exuberant, and the gigantic fields are rich in pasture of many varieties. As Darwin says, "One everywhere meets Nature's marvels which seem to have been constructed by man."

Although this area is situated almost entirely in the Torrid Zone, the climate of Brazil is rendered sufficiently pleasant by the trade winds. Between Parana and Rio Grande do Sul, the year has its four seasons, but from Bahia to Amazonas, the summer is continuous, and divides itself into a dry and a rainy period. Between the States of Parana and Bahia, however, the summer and winter are

unmistakable, and in all the three regions just mentioned the natural wealth of Brazil is incomparable. The fertility of the soil is extraordinary, and thus lends itself to all large agricultural enterprises.

As agriculture is one of the greatest assets of the country, the governments have paid much attention to developing this industry and particularly the raising of livestock. The result is that there has been a large increase in the dairy industry, which up to four years ago had received but scant attention from the governing powers, but which is now being organized, and is passing through a period of considerable prosperity.

Not all the States of Brazil have a dairy industry; it is only those of Santa Catharina, Parana, Rio Grande do Sul, and Minas Geraes which have attempted to develop this business. The other States, like Sao Paulo and those to the north, have not taken any interest in this industry, as compared to those above mentioned.

Sao Paulo, however, has possibilities for great development, and there are indications that the cattle breeders are preparing to open a vigorous campaign in this line of business.

The topographical conditions of Brazil are extremely varied; sometimes one finds large open plains that extend beyond the reach of the eye; at other places the land is broken up by hills and mountain chains, which afford good pasture and provide excellent feeding for livestock of all sorts. In the north and northeast one finds great numbers of native cattle and the zebu, for which the rough conditions are admirably suited.

As a matter of interest, a few native characteristics might here be mentioned. Butter, for example, is made in bottles in certain parts of the country and is called butter oil. In a particular locality, fine-flavored cheese is made in an unusual manner which can not be imitated in other districts. This special cheese is known on the market under the name of "requeijao do nordeste."

The States that go in for the dairy business have cattle imported from America and Europe, and use them for crossbreeding purposes.

THE MILK-PRODUCING LIVESTOCK OF BRAZIL.

The census of 1920 includes the following figures relative to cattle, sheep, and goats:

	Head.
Cattle-----	34, 271, 324
Sheep-----	7, 933, 437
Goats-----	5, 086, 655

These figures give Brazil a high position among livestock-producing countries.

Rio Grande do Sul, the State that takes the first place, has 8,489,496 head of cattle and 4485,546 head of sheep, but only takes the twelfth place in goats, with 94,413.

The second State is Minas Geraes, with 7,333,104 head of cattle, 310,938 sheep, and 203,102 goats.

In the third place comes the State of Goyaz, with 3,020,469 cattle; in the fourth place comes Matto-Grosso with 2,831,667; then Bahia, in the fifth place, with 2,698,106; then Sao Paulo, sixth, with 2,441,989; and Piauhy takes the seventh place, with 1,044,734. In respect

to goats, Bahia has the highest number, with 1,419,761, and she also occupies the second place in sheep, with 954,617.

The greater part of the dairy cattle are grade Holsteins, but there also exists in Brazil an old native breed called "Caracú," which is highly valued and really possesses commendable qualities; it is a fair milker, very strong, and good for crossing with pure European breeds.

Many animals have been imported from Europe. This is largely due to propaganda, and the interest of the Government in promoting the improvement of the breeds. Among the breeds imported are Swiss, Simmental, Jerseys, Guernseys, and Holsteins, all of which are found in the State herds. It has happened, however, that many breeders have become disheartened by the damage done by the piroplasmoses to the cattle brought over from Europe. These men have found, in the law of least resistance, an apparent escape from this loss through the importation of Indian cattle.

Some Brazilian breeders are more or less convinced that mixing zebu blood with European stock strengthens the stock, and thus enables it to better withstand the attacks of pests and the effects of a tropical climate.

This opinion has prevented the use of sound judgment in a strict selection, which was the only thing that could have brought about much improvement. It is furthermore to be observed that in some states like Santa Catharina and Parana, where the milk industry has promoted the breeding of cattle, especially for milk production, some selection has been made but few results have been attained. Notwithstanding this, these States possess about 615,500 head of cattle.

Parana, and especially Santa Catharina, are the States in which the dairy industry is best organized, while Minas Geraes supplies the largest quantity of milk.

In Rio Grande do Sul, the value of cattle lies chiefly in meat, and the milk trade is of only secondary importance.

Even in the principal States, the question of food supply for milk-producing cattle has not been developed along scientific lines. The cattle live in the country and eat what they can find: they are seldom kept under shelter. The indigenous pasture consists of *Tistegis glutinosa*, *Andropogon rufus*, etc., and throughout the whole year, the cattle eat only that which nature provides them; but to this general rule, however, there are a few exceptions. There are cattle breeders who possess animals selected particularly for milk production, and who grow special feeds, which they plant and store for the purpose. This is quite common in Santa Catharina, Parana, and in some of the cities of the States of Minas and Rio.

ANNUAL PRODUCTION OF MILK.

No reliable figures can be given respecting the milk production of Brazil, as in no State does there exist a milk-production registry.

Even in those States where the industry is most developed, it is only possible to give a rough estimate. You can say, however, that throughout the country there is milk; in some States it is in abundance, while in others the supply is moderate or scanty.

When you speak of the milk and dairy industry in Brazil, it is generally understood that you are speaking about the States of Minas Geraes, Rio de Janeiro, Santa Catharina, Rio Grande do Sul, Parana, Sao Paulo, and Goyaz; but the two last mentioned are only small producers.

PRODUCTION OF MINAS GERAES.

The annual production of the State of Minas Geraes is 820,000,000 liters. That is to say, this figure is the average of the last three years.

The large State of Minas Geraes is the richest in Brazil, whether it be considered as to its animal, vegetable, or mineral wealth. It has an extension of 975 kilometers from north to south and 1,260 kilometers from east to west. The area is 830,000 square kilometers, with a population of 4,600,000 inhabitants. The mountainous nature of the territory throughout is a great impediment to the raising of purebred cattle, but in Minas Geraes, however, there is nevertheless a great enthusiasm for stock raising; and in regard to the milk and dairy business, this State takes the first place.

From a dairying standpoint, the whole State can be divided into the four sections, Matta, Centro-Oeste, Sul, and Triangulo Mineiro.

The first section is about 275 kilometers (average distance) from Rio de Janeiro. This zone is served by two railways that take milk to the capital.

The second section consists of districts that pay great attention to the milk and dairy business. The distance between the chief milk centers and Rio averages about 270 kilometers; and if the transport service of this district were organized, over 30,000 more liters of milk would be sent to Rio daily for the consumption by the people. The difficulty in transport could really be easily overcome; because in order to bring milk to the capital it is only necessary to arrange for transferring it from train to train. Unfortunately, the milk has to be carried over three different lines, all of which belong to the Federal Government.

The third section is situated on high ground where the climate is quite cool and very healthy and the average distance from Rio de Janeiro is about 370 kilometers. There are other districts in this section which are interested in milk trade. They are located about 400 kilometers from Rio, and it is a pity that they don't cooperate in supplying milk to the capital, as they could ship 30,000 additional liters (quarts) daily out of the State.

The fourth section is called Triangulo Mineiro. The people here are very prejudiced in favor of zebus; so as might be expected, but little milk is produced in that locality. In fact, the breeder's preference for zebus almost excludes them from all participation in the milk trade.

Estimates of cattle in the four sections of Minas:

MATTA.

Area	kilometers--	24, 000
Cattle		631, 063
Cows		316, 000
Milk production	liters--	139, 300, 000

In this district, the predominating breeds are Creoles and Holstein.

SUL.

Area -----	kilometers--	42, 000
Cattle-----		1, 231, 088
Cows -----		506, 230
Milk production-----	liters--	183, 946, 000

The predominating breeds are Creoles and Holsteins.

CENTRO-OESTE.

Area -----	kilometers--	80, 000
Cattle-----		1, 404, 228
Cows -----		577, 340
Milk production-----	liters--	164, 766, 000

Chief breeds are Creoles and zebu.

TRIANGULO.

Area -----	kilometers--	93, 000
Cattle-----		1, 462, 228
Cows -----		487, 427
Milk production-----	liters--	68, 630, 100

In this district the cattle are mostly zebus and Creoles, but there are more of the former.

The State of Minas may be said to contain even a fifth cattle division, which is called Sertao (interior), and whose area is 336,000 square kilometers. This land sustains 2,047,296 head of cattle, of which 682,430 are cows, producing an average of 94,175,500 liters annually.

COMMERCIAL UTILIZATION OF MILK IN THE STATE OF MINAS.

The following are the industrial uses of milk produced by Minas: Cheese, butter, condensed milk, casein, lactose, and milk powder.

In 1920, Minas produced 808,372,500 liters of milk, of which 20,000,000 were exported; 217,500,000 were consumed at home; 279,312 were used in making cheese; 279,300,000 in making butter, and 12,060,000 liters were used for various purposes.

Everything leads one to suppose that this important business in Minas Geraes will assume even larger dimensions. It is necessary, however, to run the business on common-sense lines, and to work on the new principles that are gradually being introduced.

VALUE OF THE MILK PRODUCTION IN MINAS.

According to the official calculation, the annual value of the milk production is 249,000 contos, or, let us say, \$62,250,000. These figures are based on a normal exchange, at a price of 300 reis (75 cents American money) per liter. As of a total production of 800,000,000 liters, however, 27,931,200 are used for making cheese, 12,695,454 for butter, 217,500,000 for home consumption, and 12,060,000 in the manufacture of casein, lactose, and milk powder. It follows, then, that the Minas production amounts to, roughly, 304,000 contos, or some \$76,000,000 annually. This calculation gives merely an approximate idea of the value of the milk and milk products of Minas.

Official value of milk and milk products from Minas going into interstate trade, 1919.

Milk-----	\$2, 030, 000
Butter-----	4, 000, 000
Cheese-----	5, 500, 000
Cream-----	970

The shipment of milk from Minas began in 1894, and butter followed suit in 1899, while cheese was shipped out as early as 1882, and since that time the shipments have increased extraordinarily.

SYSTEM OF SUPPLYING MILK TO THE CITY OF RIO DE JANEIRO.

The capital of Brazil does not yet rank among the cities that consume much milk. The city is supplied by dairies in the urban, suburban, and rural districts, and from the States of Minas and Rio.

The production from the first mentioned source averages 44,752 liters daily, which are produced by 4,752 cows, mostly native or Holstein.

These animals live permanently in barns and are kept on a defective food diet, but they produce very good milk.

In the city barns, the animals are milked twice a day; once in the morning, and again at 2 o'clock in the afternoon, and the milk is distributed in bottles that contain a liter, or half a liter, and are examined by the Saude Publica. The Federal District has a total of 345 cow barns.

The Departamento Nacional de Saude Publica, acting under legal powers invested by the municipal government, should order suitable granges to be constructed in certain districts. Such an action, would at the same time, bring about a better organized service of milk supply, and an increased production. Also, at the present time, the price of milk is too high and such a measure would serve to bring it down. Incidentally, it might be mentioned that each of these cow barns pays a tax of \$50 annually.

The milk brought in from outside comes from the principal milk-producing districts of the States of Minas and Rio, and it is sent to three stations, where it is examined by the Saude Publica. The milk is Pasteurized in the Minas and Rio establishments, and placed in cans of 50 liters. It is then frozen. When these processes have been completed, the milk is put on the railway cars which, unfortunately, are old and unsuitable for the purpose.

There are in all 27 establishments in Minas and 15 in the State of Rio that prepare milk for shipment. During the year, they send about 60,000 liters daily to the capital. This, added to the milk from the cow barns, makes a total of 104,752 liters for the Rio population. The Rio de Janeiro population is 1,300,000, so this makes an average of 1 liter for every 12 persons, or 83 grams for each inhabitant.

Nearly all milk from the interior is sent to the milk stations (which number 182), where the public buys at a price which is still high.

The Saude Publica made compulsory regulations for the proper preservation of milk, and does not permit a temperature of over 15° C. or under 60° C. in the milk barns where it is served warm to the public.

The chemical composition of the milk from these States shows that it is of first quality. It is no uncommon thing for the milk to contain 5 per cent of fat, and frequently the percentage is higher.

At the present time, there is a campaign in favor the increasing the consumption of milk in the Federal District, and also of suitably organizing the sanitary control. In this campaign all the Government departments are deeply interested.

CONDITIONS OF THE MILK INDUSTRY IN THE STATE OF RIO.

From the point of view of the milk trade, the State of Rio can be divided into three districts: namely, Parahyba, Serra Acima, and Zona Mixta.

District of Parahyba.—This district is the most important, and contains an area of 10,000 square kilometers, and cattle to the number of 270,000; of these, 135,000 are cows.

The chief pasture herbage consists of capim gordura, jaragua, Pernambuco, lanceta dos campos, and Angola.

The average altitude is 400 meters, and the highest point is the peak of Itatiaya, in Mantiqueira, which attains a height of 2,860 meters.

The breeds of cattle are Swiss, Simmental, Jersey, Guernsey, and Holstein, and throughout the entire district the zebus are to be found; in certain localities the zebus outnumber the others. The average milk production of each cow is 430 liters annually, and the average fat percentage of the milk is 3.8. The most common cattle diseases are foot-and-mouth disease, symptomatic carbuncle, and anthrax. The whole district is served by three railroads. The annual milk production is approximately 58,000,000 liters.

District of Serra Acima.—This region contains all the highlands of the Serra do Mar, and has an area of 6,500 square kilometers, while the average altitude is 500 meters. The municipalities of Petropolis, Therezopolis, and Friburgo contain the highest ground, and the Serra dos Orgaos attains a height of 2,250 meters. The cattle one finds in this district are chiefly zebus. There are, altogether, about 50,000 cows.

The milk given by each cow averages 280 liters annually, and it contains about 3.8 per cent of fat. The total yearly production of the district is, roughly, 14,000,000 liters. This district also possesses a railway.

District of Zona Mixta.—All the State of Rio de Janeiro is more or less pastoral, both near the coast and in the interior; but as you approach Campos, cattle raising gradually diminishes and gives place to sugar planting.

The pasture in this district consists of grass, lanceta dos campos, and Pernambuco and Angola grass; the cattle are Creoles, which are very similar to the curraleiro of Minas and zebus. As regards altitudes, the land is mostly low and swampy, but in certain municipalities a fair height is attained.

The area of this district is 52,500 square kilometers, and it sustains 190,000 cows, which give an average annual yield of 120 liters each, or a total production of 94,800,000 liters.

Shipment from the State.—The dairy business of this State has increased much in recent years, and whereas the shipments of butter and cheese were, respectively, 31,712 and 71,208 kilos in 1920, they suddenly rose to 57,322 and 102,434 kilos in 1921.

Of the municipalities of this State, special mention is due Cantagallo.

Cantagallo.—This municipality has an area of 934 square kilometers and a population of 37,112, while the standing value of the land is estimated at \$13,252,900.

The plantations cover an area of 6,421 alqueires, and the pasture land extends over 16,293 alqueires; while there are more than 90 farms, of which many are purely cattle farms. At the present time there are more than 42 dairy factories, which produce butter, cheese, and requeijao. The cattle in this district consists chiefly of cross-breeds of zebu with Holstein, Swiss, and Caracú, and the annual milk production is about 4,000,000 liters.

STATE OF SANTA CATHARINA.

Of all the States in Brazil, Santa Catharina is the one that is best organized in regard to the dairy industry. In fact, this State is the only one that is really organized for the industry, and the amount of the production is almost as large as that of Minas Geraes.

In 1892, Santa Catharina shipped 187,570 kilos of dairy products, and in 1902 the amount had risen to 531,814 kilos, while at the present time the average annual shipment is about 800,000 kilos.

The two municipalities that have taken the most interest in the milk industry are Blumenau and Joinville, but in other parts little is done, and not much intelligence is shown in the matter. The lack of development is certainly not due to any lack of favorable natural conditions, as the altitude is suitable and the pastures rich and extensive. It is due, rather, to the distance that these places are from the market, and also partly to the lack of activity of the European colony.

Blumenau.—A German philanthropist, Dr. Herman Blumenau came to this State in 1850, and with the help of others founded a colony, which to-day bears his name, and is called Sao Paulo de Blumenau. This colony is situated on the banks of the River Itajahu-assu, a river with five large tributaries.

The climate is temperate, and the thermometer on the coast rises as high as 30° C. in summer and descends as low as -10° C.

The means of communication are railroads, State roads, and rivers. An increasing traffic passes through the port of Itajahy and the Jaragua station.

The cattle are calculated at 43,000 head, of which 19,000 are milk cows, and are nearly all Creole and Holstein crossbreeds. Fortunately, in this municipality the animals are attended to with the utmost care.

The pasture here consists of a broad blade, capim gordura, alfalfa, sugar cane, and various roots. The animals pass half their time under cover, and the cows get supplementary feeding.

There are more than 20 factories, milk establishments, and these are divided into smaller factories and departments, especially ar-

ranged for the manufacture of butter. Some firms are also preparing lactose.

All these milk products are packed in small quantities and very well labeled with the trade-mark on the butter tins, and a description of the nature of the goods—if prepared from pure-milk cream, if preserved, renovated, or to be used for cooking purposes only.

The butter is nearly all sent to the ports of the north of Brazil.

The shipments of cheese amount to about 180,000 kilos. As regards the milk production of the State of Santa Catharina, it can be put down as being roughly about 370,000,000 liters annually.

This figure is based on the fact that the State contains 210,000 cows, and that each cow gives something less than 5 liters daily.

There is one thing that has greatly assisted in development of the milk trade, and that is cooperation. There are several cooperative associations that work with considerable success. They are formed by cattle breeders who bind themselves to send their milk to the association, and they participate in the profits and privileges.

In the municipality of Joinville the milk industry has an aspect exactly the reverse. There the colonists themselves prepare their product and then send it to the factories to be sorted and classified. The final preparation of the butter in Joinville is done by 15 factories, and the annual production is about 73,000 kilos.

STATE OF PARANA.

In this State the conditions are most inviting to enterprise in the milk business; however, the trade is still in its infancy. The municipalities of Pirahy, Castro, Jaguaryayva, Ponta Grossa, and Curitiba have good factories and dairy farms which are well taken care of.

There are some establishments that have purebred Holstein cattle, which are kept on suitable rations, and each animal produces from 15 to 20 liters daily.

The pasture consists of the broad native grass, and grass which has been introduced from other parts. It should also be observed that maize, barley, wheat, oats, cabbage, and turnips are cultivated on certain estates for feeding the cattle. In time of drought, forage is preserved in silos.

The State of Parana possesses 540,000 head of cattle, and the annual production of cheese averages about 50,000 kilos.

STATE OF RIO GRANDE DO SUL.

Although the State of Rio Grande do Sul has a larger number of cattle than any other State of the Brazilian Federation, she has, nevertheless, not developed her milk industry in proportion to the number of her animals.

This is because the cattle are selected for meat purposes, and consequently the business in dry meat assumes large proportions, and meat in different forms is shipped on a large scale.

It will be seen, however, that interest in the milk trade is gradually increasing, and perhaps in the near future it will take its place as one of our most important industries.

At the present time, in the State of Rio Grande do Sul, there are about 70 factories in which butter and cheese are produced. The types of cheese most popular are Prato and Parmesan.

The municipalities that are most interested in this trade are: Garibaldi, Guapore, Bento Gonsalves, and Ijuhy.

In the year 1921, Pelotas, Rio Grande, Bage, and Erechim exported 3,300 kilos of butter, and 5,400 kilos of cheese to certain other States of Brazil.

Taking into consideration the magnificent pasture, the extent of territory in Rio Grande do Sul, and the enthusiasm of the people for the cattle industry, there no longer remains doubt respecting the future of the milk industry in that great State.

STATE OF SAO PAULO.

The State of Sao Paulo can not at the present time figure in the group of States that are much interested in the milk industry. The interest of the Paulistas in coffee has certainly contributed to the brilliant prosperity of their State, but so much so that they do not favorably regard cattle enterprises.

It behooves us, however, to observe that in nearly all the farms of the State, which number over 400, there are factories for cheese and butter production, and the capital of the State consumes more milk in proportion to her population than the capital of Rio de Janeiro.

In the north of the State the cattle are principally Holstein, more especially in Cachoeira, Silveiras, and Lorena, but in other districts you find Normandos and the Caracú, which is highly appreciated.

The milk supply for the city comes from the dairy barn and Pasteurization plants situated at Lavrinhas, Guaratingueta, and Cachoeira, which receive their supply from the farms, and from these factories about 7,000 liters of milk are daily sent to the capital.

There are over 2,500,000 head of cattle; and taking into consideration the highly enterprising spirit and the clear vision of the Paulistas, a great increase in the milk industry can be shortly expected.

INDUSTRIAL AND COMMERCIAL ASPECT OF DAIRY PRODUCTION.

Condensed milk.—Before the European war, Brazil was not interested in making condensed milk, as can be easily inferred from an examination of what follows:

TABLE 3.—*Condensed-milk production in Brazil.*

	Kilos.
1910.....	4, 174, 157
1911.....	3, 997, 692
1912.....	4, 246, 987
1913.....	4, 004, 677
1914.....	3, 384, 726
1915.....	2, 057, 402
1916.....	2, 004, 270
1917.....	1, 258, 822
1918.....	770, 710
1919.....	1, 297, 392
1920.....	1, 241, 538
1921.....	262, 640

Nearly all the condensed milk that was then consumed in Brazil came from abroad, but during the past 10 years, however, the situation has changed greatly.

People interested in dairy manufactures began to be interested in the condensed milk trade, and soon organized several factories in Sao Paulo and Minas Geraes, where the production of condensed milk now amounts to some tons.

The following factories are at the present time making this commodity. Ararense, in Sao Paulo, belongs to the Nestle's Anglo-Swiss Condensed Milk; Vigor, in the municipality of Itanhandu in Minas Geraes, which belongs to Oliva da Fonseca & Co.; Santa Ritense, in Sao Rita, in the State of Sao Paulo; Sitiense, in Sito, State of Minas, and Borboleta, also of the State of Minas.

Fabrica Ararense.—This factory was founded in 1910, but only began to make condensed milk in 1914. Up to that time it Pasteurized milk to supply the capital of the State of Sao Paulo, and a part of the milk was used for making butter, but at the present time much of it is also utilized in making sweetened condensed milk.

The production in 1922 was 840,000 kilos. The milk is packed in boxes containing 48 tins; each tin contains 500 grams.

It seems probable that the production will be larger in 1923, as in the first six months of this year 576 kilos had already been made.

Business in condensed milk should interest all those who are in the milk industry. It is enough to consider the large number of States in the north, where there is almost no natural milk, in order to appreciate the great future that is in store for the prepared substitute.

Fabrica Santa Ritense.—This factory was founded in 1921, and produced 55,000 kilos in 1922, while during the first six months of this year the output was 215,520 kilos. The milk condensed here comes from the neighboring districts, where there are farms with good milk cattle and rich pasture.

The Vigor factories—Sitiense and Borboleta.—These are trying to increase their production. The former already has a factory, and its product certainly ranks among the best. All these factories, situated in districts well supplied with milk and in a cool climate, are in a condition to produce on a large scale.

Chemical analysis of national condensed milk gives the following averages:

Specific gravity	1.290– 1.340
Acidity	3.000– 3.500
Fat	7.000–12.000
Total solids	72.150–79.980
Alkalinity of ash	9.296– 0.623
Ash	1.400– 2.004
Lactose (anhydrid)	12.024–14.460
Saccharose	36.076–42.200
Proteins	10.077–11.100

The unsweetened condensed milk and the milk powder are prepared on a much smaller scale.

BUTTER INDUSTRY.

There was a time in Brazil when but little butter was manufactured. The people then knew a type of butter which came from

France; and notwithstanding the fact that it consisted to a large extent of margarine, it was nevertheless much appreciated.

Soon after the war, however, things changed completely, and this commodity has almost disappeared from our import list. Even as recently as 1912 the importation amounted to about 3,000,000 kilos. In 1915, they went down to nearly 400,000, and they have now reached an insignificant amount.

The butter industry is concentrated, as might be expected, in the States where there is a large production of milk. It is also a common custom in the trade to adopt the process of re-preparing butter, and there are two types—fresh butter renovated and fresh butter preserved.

Even in the Federal district there are 15 preparing factories that produce large quantities of butter, which is sent chiefly to the States in the north of the country. These factories receive samples that are more or less altered, both from Minas and the State of Rio, and after they have been submitted to the process of renovation they are put in tins and given names, some of which are picturesque.

In 1916, the Government put into execution law No. 3070 of the year 1915, that established the inspection and commercial protection of butter. The amount of fat demanded is 80 per cent, which must be milk fat, and the acidity in renovated butter must not exceed 15 degrees.

Notwithstanding this law, it is seen that the process of renovating butter in Rio de Janeiro is still far behind the times, and everything leads one to believe that the consumption of this article will disappear from the capital with the increasing development of the milk trade in the producing States. The business in renovated butter is transacted through the ports of the northern States, while the capital is supplied from the States of Minas and Rio.

The butter production of Brazil can be put down roughly at 18,000,000 kilos annually, taking into consideration only those six principal States of the country that are most interested in the milk trade.

In Brazil there are some very good types of butter. In several cities of Minas and the State of Rio the production is of first quality, although the producers are not yet accustomed to the use of well-selected ferments. The success of the butter manufactured is assisted by the special forage conditions of the district, the good quality of the milk, and the presence of the proper bacterial ferments.

In Santa Catharina there is a good butter factory, where the German colonists conduct their business with great skill.

THE CHEESE INDUSTRY.

The increase in this industry still remains, in Brazil, as one of the results of the war. Since colonial times, however, there has always been a certain amount of cheese making of two national types, Minas and Nordeste.

The first mentioned was made on a large scale, both in Minas and Rio. As the making of this cheese was simple and unscientific, it has not up to the present served for export trade. In certain dis-

tricts of Minas, however, you find well-flavored samples; while in certain municipalities, like Araxa and Serra do Garrafao, near Pocos de Caldas, there are well-known types of cheese.

Besides these types mentioned, there are also many cheese which bear foreign marks and resemble the European cheese of which they are the imitations.

The order of scale of production of these cheese is Raina (Edam), Prato (Gouda), Port Salut, Neufchatel, Parmesan, Cheddar, Gruyère, Petit Suisse, Camembert, and Chester.

Of all these imitations, the one that deserves special mention is the Swiss cheese, which is made in Pocos de Caldas, in the city of Minas; it is not only very good, but it is so similar to its foreign prototypes that you can not distinguish one from the other. At the present time the spirit of cooperation is very active, so that the possibilities of a great development in the cheese industry in the State of Minas are ever on the increase.

The annual cheese production of Brazil can be put down at about 30,000,000 kilos, of which the State of Minas produces the greater part.

If you calculate the Brazilian production of cheese and butter at 5 milreis per kilo for each commodity, or, say, half a dollar at the present rate of exchange (August, 1923), you arrive at a total of 150,000 contos, or \$15,000,000 for cheese, and 90,000 contos, or, say, \$9,000,000 for butter.

The analyses of native cheeses give the following results:

TABLE 4.—*Analysis of native cheeses.*

Kind and origin.	Water.	Ash.	NaCl.	Fat.	Protein.	Acidity.
Parmesan:						
Minas.....	29.680	9.184	4.446	24.492	35.316	1.152
Do.....	25.068	6.940	2.525	36.118	31.603	1.080
Sao Paulo.....	26.704	8.820	4.914	33.800	30.956	1.538
Do.....	24.683	8.456	4.680	28.966	28.340	1.180
Edam:						
Minas.....	21.116	3.860	1.170	28.073	32.046	1.142
Do.....	27.350	6.160	3.040	29.460	24.634	1.296
Do.....	26.366	6.412	3.272	28.866	26.160	1.378
Do.....	24.316	4.240	1.989	27.398	29.430	.972
Requeijão:						
Ceara.....	17.660	7.440	3.625	44.732	33.136	.739
Do.....	22.825	5.768	2.223	30.708	28.994	.938
Do.....	18.880	4.980	.819	39.588	29.212	.639
Do.....	18.456	6.480	2.340	42.180	33.136	1.098
Gouda:						
Minas.....	27.433	6.580	2.453	25.666	34.444	.396
Do.....	25.948	5.760	2.574	41.728	24.198	.441
Estado do Rio.....	26.783	3.340	.920	27.350	27.250	.576
Rio Grande do Sul.....	31.804	5.346	1.521	34.376	31.610	1.440
Coboco:						
Parana.....	30.980	5.960	2.223	19.066	27.686	.368
Do.....	25.900	5.840	1.755	26.356	28.588	.648
Rio Grande do Sul.....	29.680	5.020	1.404	32.272	29.866	1.132
Chester:						
Minas.....	25.788	5.468	2.791	34.808	31.144	.972
Gruyère:						
Parana.....	24.332	6.060	2.223	25.326	33.000	1.531
Cheddar:						
Estado do Rio.....	24.140	4.460	1.253	41.984	30.738	1.404

It can be said that Brazilian cheese industry in a short time will be brought up to the same high level, both as to quantity and quality, as that of the milk industry.

In order to bring about this state of affairs, the Department of Agriculture has ordered its technical divisions to spread the necessary knowledge through the cities of the interior, and to the farmers, and thus modernize the practice in the milk industry.

To-day much propaganda is disseminated, both by circulars and traveling teachers; much has been accomplished for many industries, and the results of this campaign are now being seen.

The service of inspection has not yet been carried out with due rigor, because the industry is still in its early stages. A good inspection system should remove bad methods and introduce improved methods of manufacture. This work, however, will take some time, as there is much to be done. Not only does the cheese production require attention; also the other products, like butter, condensed milk, cream, and even milk itself are not yet produced under hygienic conditions.

SUMMARY.

The milk industry in Brazil is a great source of income: and although some of the States of the Union have been engaged in it for many years, it may be said to have progressed only since the European war.

The great interest that the industry has now aroused has not only seized business man and breeder, but even students of hygiene and the Government itself. It is probable that this may be a good reflection of the intelligent propaganda and magnificent organization of this industry in the United States of North America.

The milk production of Brazil is roughly 13,000,000,000 liters annually; and considering the number of the head of cattle, the figure is not extraordinary. The calculation is based on each cow giving three liters of milk daily, and that there are 11,400,000 cows. This figure represents a third part of the cattle of the country. It is likely that this estimate is far from being correct, as you have to take into consideration the great difference between the States extensively engaged in the milk industry and those engaged in the meat industry, which chiefly breed the zebu. However, the above figure can serve for giving a vague idea of the amount of milk produced in Brazil.

The milk industry is concentrated in Minas Geraes, the States of Rio, Santa Catharina, Rio Grande do Sul, Parana, and Sao Paulo. The federal capital is supplied from certain municipalities in the States of Minas and Rio, by means of Pasteurization and freezing plants.

The supply of the Federal District is also taken care of by the milk sent from dairies in the suburbs and neighborhood of the capital. The Department of Health inspects all the milk consumed, and seeks to improve the transportation service and hygienic conditions of the product.

The poor of Rio de Janeiro resent the high price of milk, which is the result of commercial and industrial exploitation. Fortunately, there are in Rio de Janeiro, as in other States of the Federation, free milk stations that give relief to the children's necessities.

The butter production amounts to 18,000,000 kilos annually.

There is a large trade with the northern ports in renovated butter, whose annual production can be put down at 3,000,000 kilos.

The Department of Agriculture is seeking through the dairy division to convince and instruct the producers of the great advantage of the use of well selected ferments in the making of this product. The application of the knowledge plays an important part in the better preservation of butter in countries which have a hot climate, like Brazil.

The cheese industry is already considerable, and the annual production amounts to nearly 30,000,000 kilos.

Besides the types of cheese called Minas and Requeijao, that are really native cheeses, there are also those called Edam, Swiss, Gouda, Port Salut, Neufchatel, Cheddar, Parmesan, Gruyère, Petit Suisse, Camembert, and Chester.

Although the production of these is sufficiently large, it is not yet possible to organize a regular export service, owing to the lack of uniformity and the manufacture of these products. It is for this reason then, that the Department of Agriculture is at the present time engaged in a propaganda of instruction by means of traveling teachers, who give information to producers concerning the technical and hygienic principles that should be followed in the manufacture of cheese.

Regarding the condensed milk industry, it may be said to have started 11 years ago, but it is only during the last 6 years that it has gone ahead. At the present time there are 6 factories in Minas and Sao Paulo that are working actively, and their production is such that importation from abroad has diminished considerably. In the chief capitals of Brazil there exist certain prejudices against condensed milk, which increased after the question of vitamins was again brought to the front. It is chiefly due to the medical profession that still hesitates in accepting condensed milk as food for children, but the campaign that the producers are making to prove that the technical preparation of condensed milk does not destroy the vitamins is doing away with the old prejudice and facilitating the acceptance of their commodity.

Milk, then, will be used in the manufacture of another product, which will increase the dairy industry of Brazil.

DAIRY FARMING IN JAPAN.

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The history of dairy farming in Japan is very short, dating back not more than 50 years ago. It is told, however, that cow's milk and dairy products were found in old times, but they were used merely as sorts of medicine and not as foodstuffs.

The records teach us that about 120 years ago some white cows were being kept in the district of Mineoka in Awa Province, and something like cheese was made there which was applied to medical purposes by the Shogunate government, and it was after the Meiji restoration that cow's milk and dairy products were turned to account as foodstuffs.

In 1863 a man named Tomekichi Mayeda started a dairy business in Yokohama, and later on, at the request of the Government, he removed to Tokyo, where he pursued the work of milking the white

cows above mentioned, which were then kept in the Government stables located near Kiji-bashi, now called Itchome Idamachi. It is to be regretted that we have no accurate records as to the breed of those white cows. In view of these facts Mayeda may well be regarded as the father of the Japanese dairymen.

In 1868 the Government stables were removed, and when the Cow & Horse Co. was established in Tsukiji, Tokyo, Mayeda was invited to come and take charge of the cow sheds of that company. In 1873 he went over to the United States of America, aided by the late Viscount Yuri, and brought back with him 115 milk cows. These were the first of the cows imported to Japan.

This importation of cows was followed by another of 300 cows from America made by his nephew, Kiyomatsu Mayeda, who, accompanied by a certain American, was dispatched to that country by the Government. The breeds of those imported cows were Shorthorn, Devon, Jersey, and Ayrshire. The first importation of Holstein cows was made in 1885 by the late Mr. Tsuda, and since 1888 many of that breed have been imported from America, up to the present time, through the hands of the livestock farm of the imperial household, the Sapporo Agricultural College, and traders.

Some Guernseys were also imported from America in 1889 by the Sapporo Agricultural College; and some Brown Swiss and Simmental cows by the Government and traders, respectively, afterwards, thus forming the nucleus of the prospective dairy-farming industry in Japan.

In short, dairy farming in Japan has made a remarkable progress in these 50 years through the good guidance of the Government combined with the strenuous efforts made by others. We now see milk and dairy products all over the Empire from the Saghalien Islands, up in the north, down to Formosa, in the south—an indication of future thriving, along with a promising volume of consumption as well as production.

Thus, for the present and future development of dairy farming in Japan, we are, and are to be, greatly indebted to our American friends who have supplied us with the best of their breeds, and with knowledge as well, which we sincerely appreciate.

DAIRIES AND QUANTITY OF MILK PRODUCTION.

According to the statistics taken in 1921 by the Department of Agriculture and Commerce, the number of the dairies in Japan was 5,031, and the cows over 2 years old kept for this purpose numbered 42,986, of which Tokyo-fu had 8,162 head; while those under 2 years numbered 7,950, including 1,361 head in Tokyo-fu; the total number being 50,936.

The statistics also teach us that there was an increase of some 5.7 per cent in number of cows, some 94.3 per cent in milk, and 35.82 per cent in value, in five years, from 1907 to 1911; while the number of dairies showed a decrease of some 1.8 per cent. Such changes were to be attributed to the sharp fluctuations of the market at large, and in particular to the undeniable fact that production was no match for consumption.

Those figures as above stated, however, do not include the amount of private consumption made by the owners of the cows, and also of the milk used in making dairy products, of which we have no numerical statement that is reliable; when these were added, the total amount of production might have been doubled.

The following table, showing the amount of milk consumption in Tokyo in every 10 years, from 1883 to 1921, may prove its increase year after year.

TABLE 1.—*Volume of dairy business in Japan from 1883 to 1921.*

Year.	Number of dairymen.	Number of dealers.	Number of milk cows.	Volume of production.	Average volume of production per day.	Average volume of consumption for every 100 persons per day.
				<i>Koku.</i> ¹	<i>Koku.</i>	<i>Go.</i> ²
1883.....	102	.....	590	3,336.483	29.310	0.89
1893.....	234	280	1,797	13,817.119	36.710	2.82
1903.....	363	715	5,032	33,069.236	99.600	4.78
1912.....	385	1,272	7,848	47,615.451	130.453	4.89
1921.....	310	804	7,596	78,088.671	213.472	5.99

¹ 1 koku equals 47.6 United States gallons.

² 1 go equals 0.17 United States quart.

BREED AND NUMBER OF MILK COWS.

As shown in the foregoing pages, the cows early imported comprised almost all breeds of milk cows, but changes were inevitably made in accordance with the trend of the times.

At the beginning of the Meiji era, when Tomekichi Mayeda imported some cows, only a few cows of pure breed were found, while many were of mixed breeds of red and white, including Shorthorn mixed breed, Devon, Jersey. Red Polled, and Ayrshire, of which the first named was in greatest number. But when the Holstein cow was once introduced, it soon became popular with breeders owing to its big milk production and, at the present time, in spite of the Government's efforts in encouraging Brown Swiss, Ayrshire, and Simmental, Holstein cows predominate, being found everywhere in Japan from Hokkaido down to Kyushu district. Their milk has no parallel in both quality and volume.

For instance, in Tokyo and its vicinity 90 per cent of the total head are Holstein; the remainder, Jersey and Ayrshire. As regards Hokkaido, which is going to be the center of the Japanese dairy-farming industry, the following figures were obtained in 1921:

TABLE 2.—*Breeds of cattle used for dairying in the Island of Hokkaido, Japan.*

	Ayrshire.	Shorthorn.	Holstein.	Others.	Total.
Number of cows.....	8,099	2,831	8,800	110	19,840
Percentage.....	40.8	14.3	44.4	0.5	.....

Below is given the number of all bulls in both public and private ownership, reported in 1921 by the Department of Agriculture and Commerce.

TABLE 3.—*Breeds of bulls in public and private ownership in Japan, 1921.*

	Mixed.	Pure.		Mixed	Pure.
Holstein.....	429	1,786	Brown Swiss.....	20	9
Ayrshire.....	18	232	Hereford.....		5
Jersey.....		22	French Canadian.....		1
Shorthorn.....	102	87	Others.....	126	1
Devon.....	7	23			
Simmental.....	25	7	Total.....	728	2,173

In addition to this, there are 3,815 head of so-called Japanese breed, which are not regarded as pure milk cows, making the total number of the cows in Japan 6,716, of which 2,902 are milk cows.

It can not be said that Japan has many milk cows, but they are increasing year after year. The record made by the Government in 1921 showed that the total number of Japanese cattle, including both cows and bulls, was 1,440,000, an increase of 17 per cent compared with the average number during the five years from 1902 to 1907.

For the improvement of the breeds of cattle, efforts have not been spared by the Government and people. In 1919 we imported 4 head, and in the following three years, 12, 9, and 39, respectively. These were all from America except 2 from England in 1921, the breed being almost all Holstein.

In the present year we have already imported over 50 head and will import more as years pass on.

WHAT THE JAPANESE GOVERNMENT IS DOING FOR THE IMPROVEMENT OF DAIRY FARMING INDUSTRY.

With a view to promoting interest in dairy farming, the Japanese Government established, eight years ago, a zootechnical experiment station and its two branch farms, where investigations are made about what is necessary for proper breeding, and various experiments on dairy products. Cows are also bred in the breeding farms of that institution. The Government also makes purchases of cattle of superior breed and lends out excellent sires to local governments and various breeding associations. Competitive exhibitions are often held, and prizes in money or in kind are given, such as : First prize, 100 yen¹; second prize, 50 yen; third prize, 25 yen.

Among other means of encouragement, lectures are occasionally given; import duty on cows is made free; condensed-milk manufacturers are exempted from income tax during the first three years after they start; tax on sugar is refunded; dairy products of home make are protected by a high tariff wall against the foreign-made product; a subsidy is given to such semiofficial organizations as the Central Association of Animal Industry in Japan, which takes every possible measure for promoting public interest in dairy products: all these combine to render great services for the development of the dairy farming industry in Japan.

¹ 1 yen equals \$0.498.

Similar measures are also taken by each local government that has its own breeding farm, and a livestock subsidy is annually given. For purposes of reference, we give below the estimate of such subsidies for 1920 in each prefecture.

TABLE 4.—*Subsidies in each prefecture in 1920 for encouragement of animal industry and for other industrial purposes.*

Prefecture.	Total amount of industrial subsidy.	Amount of subsidy for animal industry.						
		Total for animal industry.	For cattle.	For breeding farm.	For breed.	For prevention of epidemic.	For cattle association.	For others.
	Yen. ¹	Yen.	Yen.	Yen.	Yen.	Yen.	Yen.	Yen.
Tokyo.....	783,048	102,407	7,659	94,748				
Kyoto.....	728,222	40,828	15,861	18,750	2,500	517	3,200	
Osaka.....	365,034	2,130						2,130
Kanagawa.....	775,200	41,933	7,320	31,054		1,969		1,600
Hyogo.....	1,104,920	151,037	5,940	138,894		1,203		5,000
Nagasaki.....	586,975	11,818	6,558			580		4,680
Niigata.....	1,277,313	122,383		98,071	23,160	1,152		
Saitama.....	956,752	9,792	5,241			901		3,650
Gunma.....	554,393	29,263	5,659	16,021		1,031	2,800	3,752
Chiba.....	815,488	30,535	2,362	21,777	5,125	1,271		
Ibaragi.....	1,066,895	21,002		18,316		686	2,000	
Tochigi.....	550,490	6,424	2,039			317		4,068
Nara.....	404,067	1,624				224		1,400
Mie.....	710,182	26,838	9,607	16,031				1,200
Aichi.....	1,182,516	10,322	9,501			815		
Shizuoka.....	771,078	18,339	11,411			928	5,700	300
Yamanashi.....	383,312	8,853	7,909			944		
Shiga.....	480,551	5,445	5,011			434		
Gifu.....	838,936	47,388	1,500	41,471		417	2,600	1,400
Nagano.....	1,305,571	44,118	17,385		18,700	3,183	4,850	
Miyagi.....	593,452	38,926	5,309	28,616			1,000	4,000
Fukushima.....	1,093,973	63,311	2,224	30,587	25,250	250		5,000
Iwate.....	671,413	78,839	5,650	46,288	25,210	691	1,000	
Aomori.....	745,752	52,455	27,016	23,268		371	2,000	
Yamagata.....	936,270	44,365	4,968	35,970				3,050
Akita.....	919,224	66,647	6,248	41,388	19,000			
Fukui.....	589,755	12,322	11,438			484	400	
Ishikawa.....	824,933	43,979		42,132		647	1,200	
Toyama.....	675,897	40,089		37,589			2,500	
Tori.....	354,632	25,835		17,233		702	3,500	4,400
Shimane.....	610,643	47,846		31,044		3,202		13,600
Okayama.....	1,010,434	46,306	12,105	28,085		2,116	4,000	
Hiroshima.....	901,488	37,280	5,120	29,558		807		1,795
Yamaguchi.....	618,727	46,567	9,615	33,267		295	2,400	990
Wakayama.....	400,678	188				188		
Tokushima.....	529,163	14,621	2,545			145	11,931	
Kagawa.....	351,266	8,581		543		715		7,323
Ehime.....	872,407	34,722		31,271		601		2,850
Kochi.....	401,682	12,032	7,829			103		4,100
Fukuoka.....	736,269	886				886		
Oita.....	803,283	81,344	23,297	49,174	5,906	1,267		200
Saga.....	402,641	9,910	8,410				1,500	
Kumamoto.....	768,125	66,197		58,277		242		7,678
Miyazaki.....	558,106	73,013	9,700	60,581		372		2,376
Kagoshima.....	677,508	102,095	9,680	68,035		1,005		23,753
Okinawa.....	274,442	18,606	2,899	12,243		464		3,000
Hokkaido.....	2,134,891	139,650	19,043	88,514		4,243		27,850
Total.....	35,198,004	1,937,601	294,059	1,288,777	124,851	36,546	52,581	140,767

¹ 1 yen equals \$0.498.

DAIRY ASSOCIATIONS AND REGISTRATION.

The registration of milk cows in Japan is being conducted chiefly by the Central Association of Animal Industry of Japan. This association, with a view to developing animal industry in Japan and increasing the interest of its members, was established in 1915 by officials, professors, breeders, farmers, manufacturers, traders, and other interested persons who were prominent in animal industry circles. In 1918 the Japanese Horse Club, the Poultry Association of Japan, and the Meat and Milk Society joined the central associa-

tion; and in the following year, the Dutch Cattle Association of Japan and the Japanese Jersey Cattle Club were also incorporated into it. The present membership consists of 5,000 individuals, keeping in close touch with various local associations and united associations of similar nature.

The activities of the central association may be divided into various spheres, such as: To carry out investigations, inquiries, and experiments concerning animal industry; to lead the local livestock associations and the united local livestock associations; to promote the mutual interests of such associations and other organizations of similar nature; to investigate livestock hygiene and the prevention of epidemics; to hold exhibitions, shows, fairs, prize contests, etc.; to register purebred animals, carry out advanced registration, and issue certificates of registered animals; to publish a monthly journal and books concerning animal industry; to hold training courses, lectures, etc.; to reward corporations or individuals that have given great services to animal industry; and anything else possible.

Dairy farming, as previously stated, is comparatively a new industry to Japan, and there were no breed associations till 1908, when the Japanese Jersey Cattle Club was founded, which was followed by various other associations. Until that time the Japanese people were almost utterly ignorant of dairy industry; but, thanks to the efforts of the central association and the Government, such knowledge has been greatly popularized since 1916.

The physique of cows has also been much improved through the efforts of the association. In Table 5 are given the measurements taken of 185 cows selected by the association for milk tests and the help registration. For comparison, measurements made on other groups of cattle are given in Table 6.

TABLE 5.—Measurements made on 185 cows inspected for milk tests and the help registration by the Central Association of Animal Industry in Japan.

Age (months).	Height at shoulder.	Height at hip.	Length of body from foremost part of shoulder joint to pubic bone.	Circumference of chest.	Length from hip to end of rump.	Width of hips.	Width of thurls.
From 24 to 30 (37 cows):	<i>Shaku</i> . ¹	<i>Shaku</i> .	<i>Shaku</i> .	<i>Shaku</i> .	<i>Shaku</i> .	<i>Shaku</i> .	<i>Shaku</i> .
Average.....	4.406	4.498	5.388	6.199	1.706	1.666	1.602
Maximum.....	4.64	4.70	5.74	6.75	1.80	1.90	1.75
Minimum.....	4.15	4.29	5.00	5.60	1.55	1.45	1.45
From 31 to 36 (24 cows):							
Average.....	4.491	4.593	5.413	6.387	1.714	1.725	1.617
Maximum.....	4.80	4.90	5.80	6.75	1.90	1.90	1.72
Minimum.....	4.25	4.30	5.15	5.84	1.51	1.50	1.50
From 37 to 42 (22 cows):							
Average.....	4.476	4.533	5.359	6.377	1.749	1.748	1.643
Maximum.....	4.75	4.75	5.80	6.86	1.95	1.90	1.75
Minimum.....	4.30	4.35	5.00	5.90	1.60	1.60	1.50
From 43 to 48 (19 cows):							
Average.....	4.496	4.545	5.418	6.407	1.748	1.747	1.649
Maximum.....	4.72	4.72	5.94	6.94	2.00	1.95	1.80
Minimum.....	4.30	4.35	5.20	5.90	1.55	1.55	1.55
From 49 to 60 (27 cows):							
Average.....	4.470	4.500	5.450	6.340	1.746	1.774	1.650
Maximum.....	4.70	4.76	5.70	6.93	1.82	1.98	1.75
Minimum.....	4.24	4.23	5.00	5.90	1.65	1.61	1.51
From 61 upward (56 cows):							
Average.....	4.507	4.517	5.535	6.511	1.781	1.832	1.693
Maximum.....	4.93	4.89	6.10	7.26	1.97	2.05	1.90
Minimum.....	4.25	4.26	5.10	5.67	1.60	1.70	1.50

¹ 1 shaku equals 0.994 foot, or 0.303 meter.

TABLE 6.—Measurements made on various groups of cattle.

Animals measured.	Height at shoulder.	Height at hip.	Length of body from foremost part of shoulder joint to pubic bone.	Circumference of chest.	Length from hip to end of rump.	Width of hips.	Width of thurls.
Bulls in Friesland, measured by Doctor Lydthin.....	<i>Shaku.</i> ¹ 4.422 (134 em.)	<i>Shaku.</i> 4.521 (137 em.)	<i>Shaku.</i> 5.115 (155 cm.)	<i>Shaku.</i> -----	<i>Shaku.</i> 1.716 (52 em.)	<i>Shaku.</i> 1.782 (54 em.)	<i>Shaku.</i> 1.617 (49 cm.)
Imported American Holsteins: 3 cows, from 30 to 36 months old (average).....	4.463	4.590	5.300	6.550	1.866	1.840	1.693
2 cows, from 24 to 29 months old (average).....	4.425	4.485	5.200	6.175	1.825	1.750	1.600
1 cow, 41 months old.....	4.680	4.730	5.550	6.680	1.700	1.800	1.700
Imported Dutch cow, 31 months old, owned by Niigata Prefecture.....	4.520	4.680	5.350	6.660	1.900	1.830	1.800
Imported American cow, 66 months old, owned by Niigata Prefecture.....	4.400	4.550	5.400	6.220	1.730	1.910	1.680

¹ 1 shaku equals 0.994 foot, or 0.303 meter.

TABLE 7.—Record of milk test on 94 registered cows made during periods of 300 and 365 days in the full lactation period by the Central Association of Animal Industry in Japan.

	Age.			
	2 to 3 years.	3 to 4 years.	4 to 5 years.	Over 5 years.
Number of cows.....	22	17	12	28
<i>Milk.</i>				
Average daily production ¹.....pounds..	15,705.56	16,549.42	19,734.80	20,012.85
Highest daily production.....do.....	25,989.17	24,571.96	25,953.72	41,112.57
Lowest daily production.....do.....	11,991.30	10,670.50	13,030.50	14,893.90
<i>Fat.</i>				
Average daily production ¹.....do.....	533.3226	607.9397	720.6879	726.7278
Highest daily production.....do.....	1,063.8732	1,193.0600	966.8786	1,827.1418
Lowest daily production.....do.....	418.0430	365.8244	493.0135	499.5710
<i>Fat index.</i>				
Average.....per cent..	3.4	3.67	3.65	3.63
Highest.....do.....	5.3	3.8	4.1	4.9
Lowest.....do.....	2.7	3.1	3.1	3.1

¹ This was obviously intended to be yearly production, but it is printed as given in the manuscript.—Ed.

Milk tests are made under the supervision of competent prefec-tural officials who have been graduated from Government agricul-tural or veterinary colleges, and have good knowledge and much experience. In carrying out the test, the association assigns inspec-tors to conduct the test so as to get the strictest possible result. There are three kinds of tests, namely, 7-day test, 30-day test, and 1-year test.

Besides the central association, we have many other associations of similar kind, some leading ones being the Japan Cattle Improve-

ment Union, which issues a cattle register and a periodical as its organ, and the Japan Condensed Milk Association, whose object is to introduce condensed milk to the largest possible extent. In local districts, there are found livestock associations, cattle associations, dairymen's associations, and milk-trade associations. These are all backed and supervised by the local government to which they belong. In 1921 the number of these associations was 495, and various works are being carried out by them, such as competitive exhibitions, prize shows, milk contests, milk tests, etc. Training classes and lecture meetings are occasionally held; sales, exchanges, and loans of sires are also made through the hands of these associations.

There are many minor associations working for the same cause as their big sister associations. They are too numerous to be mentioned here.

A brief account of registration work should be given. The work is being carried out chiefly by the central association, and the registration of dairy breeds and of the so-called Japanese breed, which is not a purely dairy kind, is made also by some 18 associations in various districts, among which the Hokkaido Cattle and Horse Association is predominant.

As a means of diffusing knowledge of the dairy-farming industry, various periodicals are published, among which *The Nyu-gyu* (Milk Cow Times) is most widely read; and next come the *Livestock and Industrial Arts*, by the central association, and the *Journal of Cattle in Japan*, by the Japan Cattle Improvement Association.

DAIRY PRODUCTS.

The chief dairy products made in Japan are condensed milk, butter, and margarine. Cheese, cream, yoghurt, and casein are also manufactured. The following statistics taken by the Department of Agriculture and Commerce show the annual output during a recent five-year period of the chief dairy products of Japan.

The quantity output of cheese, yoghurt, cream, and casein is not definitely known, but the aggregate value is given.

TABLE 8.—*Production of dairy manufactures in Japan.*

Year.	Condensed milk.		Butter.		Margarine.		Other products.	Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Value.	Value.
	<i>Pounds.</i>	<i>Yen.¹</i>	<i>Pounds.</i>	<i>Yen.</i>	<i>Pounds.</i>	<i>Yen.</i>	<i>Yen.</i>	<i>Yen.</i>
1917.....	6,257,129	1,645,783	1,080,377	839,466	613,934	266,736	85,490	2,887,475
1918.....	10,896,686	4,134,393	935,438	1,060,190	587,770	224,374	172,906	5,591,863
1919.....	14,252,463	6,618,584	909,653	1,150,917	686,220	372,718	225,543	8,367,763
1920.....	12,814,596	5,831,701	818,440	1,051,419	636,590	353,519	383,175	7,624,814
1921.....	13,033,834	5,529,658	866,501	1,126,570	776,560	332,154	514,046	7,502,428

¹ 1 yen equals \$0.498.

Discussion of Table 8:

Condensed milk.—In 1919 the quantity reached its maximum, showed great decrease in 1920, and in 1921 an increase; but there was a decrease in value.

Butter.—The maximum output was made in 1919, and it showed a gradual decrease until 1921, when a little increase was made, this

fact leaving an interesting question for future consideration. The highest record in value was made in 1919, and in 1920 it showed a decrease, and a little increase in 1921.

Margarine.—While the quantity showed a gradual increase, the value, which reached its maximum in 1919, showed a gradual decrease. This fact proves the elevated standard of taste of the people.

Value of other products.—This showed gradual increases year after year.

The total value reached its maximum in 1919, and showed gradual decreases in the following two years.

That the prices of these articles were greatly raised in 1919 was entirely due to the record-breaking advance in prices that marked an epoch in the Japanese financial annals; and as its direct reaction, on one hand, and an aftermath of the monetary disturbances outside, on the other, falls took place in the market of not only dairy products but also of all commodities in Japan. Dairy products that are necessary for man's living are not to be regarded as being easily affected by the fluctuation of markets, and it would be premature to judge the future of Japan's dairy industry simply from what has been done in the past.

The number of dairy factories in Japan is as follows:

TABLE 9.—*Dairy factories.*

Year.	Number of factories.
1917.....	165
1918.....	218
1919.....	234
1920.....	222
1921.....	227

A sudden increase in the number of factories was made in 1918, and the greatest number was attained in 1919. Since then no marked change has been made up to the present time.

Of all these factories, those making condensed milk are the most thoroughly equipped. Some 25 of these factories are now in operation. The list includes a few factories of butter, margarine, and cheese, most of them being small.

TABLE 10.—*Factories operated by condensed-milk companies.*

Location.	Number of factories.	Name of company.
Hokkaido, Shizuoka.....	15	Kyokuto Condensed Milk Co. (Ltd.).
Shizuoka, Saga Hyogo.....	4	Morinaga Seika Kabushiki Kaisha.
Hokkaido.....	4	Hokkaido Condensed Milk Co. (Ltd.).
Chiba.....	4	Tokyo Kashi Kabushiki Kaisha.
Ishikawa.....	1	Hokuriku Seinyu Kabushiki Kaisha.
Toyama.....	1	Nippon Condensed Milk Co. (Ltd.).
Shizuoka.....	1	Shida Condensed Milk Co. (Ltd.).
Hyogo.....	1	Fuji Condensed Milk Co. (Ltd.).
Okayama.....	1	Okayama Condensed Milk Co. (Ltd.).
Chiba.....	1	Nippon Powdered Milk Co. (Ltd.).
Do.....	1	Bonan Condensed Milk Co. (Ltd.).
Do.....	1	Mihara Condensed Milk Factory.

¹ Including 1 ice-cream factory.

The dairy enterprises may be classified as follows according to locality:

Condensed milk.—Hokkaido, Shizuoka, Chiba, Tokyo, Hyogo.

Butter.—Hokkaido, Tokyo, Chiba.

Margarine.—Kanagawa, Hyogo, Fukuoka.

IMPORTATION OF DAIRY PRODUCTS.

The homemade dairy products often run short for the increasing demand, and a supply is being brought from abroad.

TABLE 11.—*Concentrated milk imported from 1917 to 1922.*

[From report by Revenue Bureau.]

Year	Powdered milk.		Other dried milk.		Evaporated.		Condensed milk.		Total. ¹	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	<i>Kin.</i> ²	<i>Yen.</i> ³	<i>Kin.</i>	<i>Yen.</i>	<i>Kin.</i>	<i>Yen.</i>	<i>Kin.</i>	<i>Yen.</i>	<i>Kin.</i>	<i>Yen.</i>
1917.....	4,181	1,410	29	4	308,036	85,930	4,216	1,290,613	4,558,075	1,390,302
1918.....	19,036	18,298	0	0	338,443	128,609	2,879	638,123	233,976	1,436,372
1919.....	88,524	78,323	227,878	155,225	194,230	81,593	3,516,002	2,137,722	4,060,950	2,453,473
1920.....	224,503	197,930	26	19	348,584	190,108	4,080,830	2,182,356	4,701,388	2,771,731
1921.....	702,598	675,720	0	0	777,737	444,381	4,516,669	2,466,759	6,007,162	3,580,062
1922.....	1,689,023	1,706,809	127,660	66,596	309,140	91,094	5,179,136	2,926,135	7,502,181	4,930,993

¹ In some cases the figures for years do not agree with the total.

² 1 kin equals 1.3228 pounds.

³ 1 yen equals \$0.498.

By the above table we can see that a rapid increase was made in dried milk with no sugar after 1920. This might be due to its increased use as infant's food. Dried milk with sugar was imported in large quantities in 1919 and 1922.

Evaporated milk showed great variation, an increase in 1921 and a decrease in 1922.

Condensed milk showed a decrease in 1918 against the preceding year, and ever since it has been showing a gradual increase.

The total concentrated milk showed a decrease in quantity and an increase in price in 1918 against the preceding year; and a yearly increase in quantity after 1918, and in price after 1917, has been effected.

The chief countries from which condensed milk is imported are Australia, United States, Canada, Switzerland, and England.

TABLE 12.—*Importation of butter, margarine, cheese, and infant's food.*

[From report by Revenue Bureau.]

Year.	Butter and margarine.		Cheese.		Infant's food.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	<i>Kin.</i> ¹	<i>Yen.</i> ²	<i>Kin.</i>	<i>Yen.</i>	<i>Kin.</i>	<i>Yen.</i>
1917.....	16,145	16,401	45,087	39,127	102,134	81,885
1918.....	6,132	6,181	65,885	71,817	141,588	152,162
1919.....	25,901	35,178	47,889	60,336	221,343	259,122
1920.....	303,883	415,455	95,201	122,515	295,864	285,499
1921.....	203,191	249,561	73,360	81,439	293,127	287,291
1922.....	532,033	572,816	102,130	108,671	137,847	253,904

¹ 1 kin equals approximately 1 pound.

² 1 yen equals \$0.498.

Butter and margarine showed a decrease in 1921, but a great increase in 1922; and the tendency is toward increase at the present time. They are imported chiefly from Australia, the United States, Holland and England.

Cheese, like butter, showed a decrease in 1921 and an increase in 1922. It is imported chiefly from the United States, Australia, Canada, and Holland.

Infant's food gained its maximum in 1920, and showed a gradual decrease after that year. The United States and England supply it mostly.

TABLE 13.—*Exportation of dairy products.*

Year.	Condensed milk.		Butter and margarine.		Cheese.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	<i>Kin.</i> ¹	<i>Yen.</i> ²	<i>Kin.</i>	<i>Yen.</i>	<i>Kin.</i>	<i>Yen.</i>
1917.....	1,754,190	489,578	47,933	24,860	.....	.....
1918.....	1,652,060	908,323	110,858	86,622	36	50
1919.....	2,801,147	1,648,004	83,835	67,461	54	84
1920.....	468,496	308,293	78,976	36,543	222(?)	157
1921.....	366,729	125,185	26,058	21,968	191	192

¹ 1 kin equals approximately 1 pound.

² 1 yen equals \$0.498.

Discussion of Table 13:

Condensed milk.—Gradual increase after 1917, maximum in 1919; gradual decrease after that year. Exported to chiefly Kantoshu, China, Straits Settlements, Hongkong, and Russian Asia.

Butter and margarine.—Maximum in 1918, gradual decrease after that. Exported to Kantoshu, Russian Asia, and China.

Cheese.—No remarks are needed, as its exportation is very small.

DOMESTIC CONSUMPTION OF DAIRY PRODUCTS.

No accurate reports could be obtained as to the amount of the domestic consumption of dairy products. The information in Table 14 is only a presumption made by deducting the export amount from the total amount of production and adding the import amount thereto.

TABLE 14.—*Consumption of manufactured dairy products per 100 persons per year.*

Year.	Con- densed milk.	Butter and marga- rine.	Cheese.
	<i>Pounds.</i>	<i>Pounds.</i>	<i>Pounds.</i>
1917.....	16.3	1.7	0.08
1918.....	17.1	2.0	.11
1919.....	24.3	2.2	.08
1920.....	24.7	2.5	.17
1921.....	33.0	3.2	.12

As to milk production and its domestic consumption, the following figures have been obtained:

TABLE 15.—*Production and consumption of milk.*

Year.	Total amount of milk produced.	Amount of consumption by every 100 persons per year.
	<i>Koku.</i> ¹	<i>Sho.</i> ²
1917.....	338,644	60.4
1918.....	336,195	60.4
1919.....	335,115	59.6
1920.....	352,494	63.0
1921.....	454,611	80.1

¹ 1 koku equals 47.5 United States gallons, or 179.89 liters. ² 1 sho equals 1.92 quarts, or 1.76 liters

When the amount of the milk used in making each dairy product is added to the amount of milk consumption above stated, the total consumption of milk by every 100 persons per year will be as follows:

TABLE 16.—*Estimated total consumption of milk in various forms, by every 100 persons yearly.*

Year.	As condensed milk.	As butter.	As cheese.	As fluid milk.	Total.
	<i>Sho.</i> ¹	<i>Sho.</i>	<i>Sho.</i>	<i>Sho.</i>	<i>Sho.</i>
1917.....	13.7	14.3	1.3	60.4	89.5
1918.....	13.7	17.4	1.8	60.4	93.3
1919.....	19.4	19.1	1.3	59.6	99.4
1920.....	19.8	21.7	2.7	63.0	107.2
1921.....	26.4	27.8	1.9	80.1	136.2

¹ 1 sho equals 3.4 British gallon, or 1.76 liters.

Evidently the amount of the domestic consumption of milk is increasing year after year.

ICE CREAM.

Until recent years ice cream making as an industry had been almost neglected; it was conducted only in the private family. The demand for ice cream, however, has grown remarkably in these years, and in 1921 the Kyokuto Condensed-Milk Co. (Ltd.) first started in this business on a large scale, an example which was followed by many interested persons.

Figures on ice cream can not be obtained, but we believe that the amount of it consumed must be great, and that the industry will steadily flourish as improvement is made in quality.

APPENDIX.

THE REGULATION FOR THE CONTROL OF THE TRADE IN COW'S MILK.

The matters of public health relative to cow's milk are being put under the control of the sanitary bureau of the Department of

Home Affairs, and its regulation is enforced through the hands of the police department of each local government. The regulation consists of two ordinances, one being issued by the Department of Home Affairs and the other by the local government. The former is for control of the trade in cow's milk, and applies to the whole land of Japan, except her colonies, such as Chosen, Formosa, and Saghalien; while the latter consists of the rules for the production and sale of milk. The range of its adaptation covers two kinds of milk, whole milk and skim milk, and three kinds of dairy products, condensed milk, condensed skim milk, and powdered milk.

Such rules treat in detail the matters regarding the health of cows, sanitary condition of dairies, materials, and quantity indication of vessels, and health of milkmen. They also give a certain chemical standard to city milk as regards its constituents.

The present regulation, which is given elsewhere in these pages, was enacted in 1899, and leaves much to be desired. Its amendment is now in hand so as to make it more suitable to the present conditions of social progress.

Following is a translation of the law regulating the trade in milk:

REGULATIONS FOR THE CONTROL OF THE TRADE IN COW'S MILK.

(Home Department Ordinance No. 15, 1900; amended by Home Department Ordinances No. 7, 1906; 17, 1910; and 17, 1917.)

ARTICLE I. By the term cow's milk in these regulation is understood whole milk and skim milk intended for sale; and by the term articles made from milk is understood condensed milk, condensed skim milk, and powdered milk intended for sale.

By the term trader in milk is understood a person who makes it his trade to extract, manufacture, or sell wholesale or at retail cow's milk or articles made therefrom.

ART. II. The specific gravity of cow's milk shall be, at 15° C., from 1.028 to 1.034 for whole milk and from 1.032 to 1.038 for skim milk.

The quantity of fat in whole milk shall be not less than 3 per cent.

The amount of solids in skim milk shall be not less than 8.5 per cent.

ART. III. The amount of fat in condensed milk shall be not less than 8 per cent.

The amount of cane sugar to be contained in condensed milk or condensed skim milk shall not, with milk sugar included, exceed 5.50 per cent.

ART. IV. A person who proposes to engage in milking cows or making articles from milk must obtain therefor the permission of the local governor.

The local governor shall, when he gives the permission mentioned in the present article, cause a sanitary expert to examine the structure and accommodations of the place where milk or articles made therefrom are to be handled.

ART. V. Traders in milk shall not draw milk from cows of the following descriptions:

1. Cows suffering from cattle plague, anthrax, contagious pleuropneumonia, foot-and-mouth disease, hydrophobia, tuberculosis, cowpox, jaundice, actinomycosis, symptomatic anthrax, dysentery, udder disease, pyemia, uremia, septicemia, poisoning, aphthae, septimetritis, and other febrile diseases.

2. Cows being treated with a poisonous or powerful medicine which is likely to enter into milk.

3. Cows within seven days after parturition.

ART. VI. Traders in milk shall not use for holding or measuring milk or articles made therefrom, vessels made of zinc, copper, or brass, earthenware badly enameled and covered with injurious glaze or vessels covered with enamel containing lead.

ART. VII. Traders in milk shall not be permitted to sell, or transport or store with a view to sale, milk of the following descriptions:

1. Putrified.
2. Viscous or of bitter taste, or presenting a blue, red, or any other abnormal color.

3. Containing foreign matter.

4. Drawn from a cow to which any of the descriptions in Article V applies.

5. Not conforming to the provisions of Article II.

ART. VIII. Traders in milk shall not be permitted to use milk described in any of the first four items of the preceding article as material for making articles from milk.

ART. IX. Traders in milk shall not be permitted to sell, or transport or store with a view to sale, the following descriptions of articles made from milk:

1. Putrified.

2. Mixed with foreign matter.

3. Held in any of the vessels mentioned in Article VI.

4. Made from the milk mentioned in the first four items of Article VII.

5. Condensed milk or condensed skim milk which does not conform to the provisions of Article III.

ART. X. Traders in milk shall clearly state on the vessels for distributing milk whether they contain whole or skim milk; and on the vessels with condensed milk or condensed skim milk, whether they contain condensed milk or condensed skim milk.

Traders in milk shall not be permitted to put skim milk into a vessel marked whole milk, or to put condensed skimmed milk into a vessel marked condensed milk.

ART. XI. Traders in milk shall always keep clean the places where vessels for holding and measuring milk and articles made from milk, and where milk and articles made therefrom are handled.

ART. XII. Traders in milk shall not allow persons suffering from tuberculosis, leprosy, syphilis, or any other infectious or contagious disease to handle milk, articles made therefrom, or vessels for holding or measuring them, nor admit them into places where they are handled. The same rule shall correspondingly apply when the traders themselves are infected with such diseases.

ART. XIII. Traders in milk shall isolate cows afflicted with infectious or contagious diseases.

ART. XIV. The local governor may cause a competent officer or sanitary expert to examine cows kept by a trader in milk, and if there is a cow among them afflicted with certain diseases, to brand a number or mark on its horn or to hang on its ear lobe a ring bearing the number or mark.

The number, mark, and earring mentioned in the preceding clause shall not be erased or removed without the permission of the Government officer.

ART. XV. The local governor may take the measures prescribed in article I of Law No. 15, 1900 (law for the control of foods, beverages, and other articles), with respect to cows mentioned in Article V of the present regulations, milk and articles made therefrom for which the vessels mentioned in Article VI are used, milk mentioned in any of the items in Article VII, and articles made from milk mentioned in any of the items in Article IX. The same rule applies also with respect to traders who contravene the present regulations.

ART. XVI. For the execution of the present regulations the local governor may exercise the authority prescribed in Article II of Law No. 15, 1900 (law for the control of foods, beverages, and other articles).

ART. XVII. Any person who infringes the provisions of the second clause of Article XIV shall be liable to a fine not exceeding 100 yen, or imprisonment.

ART. XVIII. Any person to whom either of the following clauses applies shall be liable to a fine not exceeding 100 yen:

1. Any person who engages without permission in the trade mentioned in Article IV.

2. Any person who infringes any of the provisions of Articles V to IX.

ART. XIX. Any person who infringes any of the provisions of Articles X to XIII shall be liable to a fine not exceeding 50 yen.

ART. XX. If a trader in milk is a minor or a person adjudged incompetent, the penal provisions applicable to him in the present regulations shall apply to his legal representative; this rule, however, does not hold in the case of a minor who possesses the same capacity as an adult in regard to his business.

In the event of an agent of a trader in milk, the head of his house, a member of his family, an inmate of his house, or a person employed by him or otherwise taking part in his business, infringing the provisions of the present regulations in regard to the said business, such trader shall not escape penalty on the ground that the infringement did not take place by his direction.

In the event of the representative of a juridical person or a person employed or otherwise taking part in its business, infringing the provisions of the present regulations in regard to the said business, the penal provisions prescribed in these regulations shall apply to the said juridical person.

In case of punishment of a juridical person the representative thereof shall be the accuser.

ART. XXI. The present regulations shall come into effect on the 1st of July, 1900.

ART. XXII. The local governor shall determine the structure, accommodations, and supervision of cowsheds and places to be used for milking and making articles from milk.

ART. XXIII. In Tokyo Prefecture the duties of the local governor shall be discharged by the inspector general of the metropolitan police.

SESSION 27. DISEASES OF DAIRY CATTLE.

Honorary chairman, Sir ARNOLD THEILER, dean, veterinary faculty, Transvaal University College, South Africa.

Chairman, Dr. LOUIS A. KLEIN, dean, the School of Veterinary Medicine, University of Pennsylvania.

Secretary, H. A. RUEHE, head of the department of dairy husbandry, University of Illinois.

FIRST BAPTIST CHURCH ASSEMBLY HALL,
Syracuse, N. Y., Wednesday, October 10, 1923—9.30 a. m.

Chairman KLEIN. Ladies and gentlemen, the time for opening this session has arrived, and I think it advisable to begin now, since we have rather a full program. This session will necessarily be conducted in accordance with the rules of the congress which specify that, in so far as is possible, the papers shall be limited to 20 minutes, and the discussion to 5 minutes for each individual speaker, and, if possible, 10 minutes for the subject.

The first number on the program is an address on "Protozoan diseases of dairy cattle," by Sir Arnold Theiler, dean of the veterinary faculty, Transvaal University College, South Africa. Sir Arnold Theiler. [Applause.]

PROTOZOAN DISEASES OF DAIRY CATTLE.

Sir ARNOLD THEILER, K. C. M. G., director of veterinary education and research for the Union of South Africa, professor of pathology in the veterinary faculty of the Transvaal University College, Pretoria, South Africa.

The experience upon which the present article is based has been acquired in South Africa, a country in which protozoan diseases play a very important rôle, interfering with the settlement of large tracts of land and limiting the economic exploitation of livestock. The writer has been fortunately situated in respect to the study of such diseases, inasmuch as the commencement of his investigations coincided with the period of reconstruction after the Anglo-Boer war, at a time when the repopulation of the country with cattle was in active progress. The geographical situation of South Africa, within easy reach of all continents, was conducive to importation from all sources. The introduction of highly susceptible cattle led to a recrudescence of indigenous diseases, while even those immune to local infection frequently introduced new diseases.

In addition to these opportunities for study within the Union itself, opportunities for personal observation in other parts of Africa occasionally presented themselves.

During the last decade the publication of the Tropical Veterinary Bulletin has proved of great service in calling attention to the world-wide distribution of protozoan diseases, and facilitating their correlation.

In a paper for this congress it is perhaps of greater interest to deal with the subject in a general rather than a special way, and from the mass of information at my disposal to abstract the broad principles underlying the nature and control of these diseases.

The protozoan diseases which come under consideration may be grouped as trypanosomoses, piroplasmoses, anaplasmoses, spirochaetoses, sarcosporidiosis, and coccidiosis. On grounds of similar epizootology, the disease heartwater, caused by an ultra-visible virus, may also be included. On account of their general geographical distribution, all these diseases are usually termed tropical and subtropical, although some of them also occur in colder regions.

The optimal conditions for occurrence are high temperature, and at least moderate humidity; low temperature and humidity both tend to limit their distribution.

With the comparatively recent penetration of the white man into the tropical and subtropical zones, these diseases naturally acquired greater economic importance, becoming evident as soon as he commenced to upset the preexisting distribution of native animal life. By introducing new animals, he created opportunities for the reappearance of dormant diseases, which frequently spread over wider areas. This was particularly the case in Africa; and indeed, the presence of piroplasmoses in parts of Europe, considered in the light of their distribution over Africa and Asia, suggests the view that protozoan diseases were originally characteristic of the Old World and subsequently spread into the New World.

Generally speaking, such diseases have gradually disappeared from the highly cultivated parts of Europe, and find a refuge in unexploited regions only which remain comparatively virgin to the plow of civilization. Although disappearance of these diseases follows in the wake of intensive cultivation, the process is too slow for modern exploitation of new areas, and other methods must therefore be found. This requires careful study on true scientific lines, and much remains still to be done. Much knowledge has, however, been already acquired, the wise application of which goes far to control the damage caused by the inevitable resuscitation of diseases which appear to be associated with the movements of the white man throughout the globe.

The first peculiarity of the protozoan diseases lies in the fact that most of the causal Protozoa require an invertebrate host for their propagation. This has been definitely proved for the majority, although for some (sarcosporidiosis and coccidiosis) the evidence is incomplete and only indirect. Even for these latter, however, there is reasonable ground for believing that an intermediate invertebrate host plays some rôle in the evolution of the parasite. The necessity for the existence of such a host explains the influence of the two most important limiting factors, temperature and moisture, upon the geographic and local distribution of protozoan diseases. Cold and draft are generally unfavorable for intermediary hosts, which commonly belong to the Arthropoda. Detection of the actual hosts, and the study of their life histories, are of course of special importance in dealing with the eradication of the diseases themselves.

A second peculiarity is the existence of "virus reservoirs" or "virus carriers" as they are commonly called. Cattle which have recovered

from a particular disease, or animals of a different species which do not suffer seriously from an infection, can act as such "reservoirs" of that disease. This fact explains the appearance of virulent infection in nonresistant cattle imported from without, and becomes of great importance when it is proposed to export resistant cattle into countries which do not possess the disease but which do possess the intermediary hosts.

A third peculiarity is that the most formidable protozoonoses are diseases of the blood, and may frequently be transmitted by mechanical methods; a fact of considerable epizootic significance.

TRYPANOSOMOSES.

These are caused by some flagellated protozoan living in the blood plasma, are all insect-transmitted, and may be conveniently discussed as follows:

(1) Transmission connected with a definite genus of Diptera, the Glossina, all species of which are implicated; *G. morsitans*, *pallidipes*, *austeni*, *swinertoni*, *brevipalpis*, *fusca*, *tachinoides*, and *palpalis*. The trypanosomes develop within the bodies of these flies, occupying the whole intestinal tract during the whole lifetime of the fly. To this class of parasites belong *T. brucei* and the *dimorphon* types, causing nagana, a disease limited to Africa and having its most southern extension in Zululand.

(2) Transmission purely mechanical and not connected with a specific intermediate host. A variety of biting flies, *Tabanus*, *Haematopota*, *Stomoxys*, and others, may effect mechanical transmission. The group includes *T. evansi* and its varieties. Distribution is wide over Asia, Africa, and a number of their geographically associated islands. It is possible that the recently described trypanosomosis of Venezuela and of French New Guiana, belongs to this class. The diseases concerned are chiefly known under the name of surra.

(3) Transmission mechanical by a variety of flies, but with a permanent intermediary host in flies of the genus *Glossina*. The trypanosomes develop in the proboscis. The *Glossina* therefore maintain the infection, various other flies acting as simple mechanical inoculators of blood from one animal to another. To this group belongs *T. vivax*, the distribution of which is limited to central Africa through a belt reaching from the Atlantic to the Indian Ocean.

(4) Transmission mechanical, but now shown to undergo also development in a *Tabanus*. Parasites of the *T. theileri* type, with world-wide distribution. Although generally considered non-pathogenic these trypanosomes may cause acute anemia under certain conditions.

So far as Africa is concerned, the various trypanosomoses are still of prime importance. They interfere with the colonization of large tracts of otherwise habitable country, and render stock raising impossible. Although the problem of their eradication is under constant consideration, no satisfactory solution has been found. It is undoubtedly allied with the eradication of the flies themselves, the existence of which is connected with the fauna; particularly with

the larger wild animals, as the history of the Transvaal shows. The Boer pioneers rendered the country habitable by clearing out the game, and nature herself provided evidence in an accidental large scale experiment in 1897. When rinderpest swept through the game areas of the Transvaal in that year, it reduced the large herds of antelope and wild pigs, and nagana disappeared entirely. In Zululand nagana was checked, but subsequently reintroduced and spread as the game increased again. White man and game are apparently incompatible in Africa, where both claim possession of the same land.

At present eradication of the flies appears to be impossible without destruction of their faunal hosts or their floral shelter, but some hope is entertained that it may yet be achieved in other ways, and with this object extensive studies into the bionomics of *Glossina* are being undertaken.

Some progress has been recently made in the drug treatment of affected animals, *T. brucei*, *T. vivax*, and *T. evansi*, being markedly influenced by "Bayer 205," while the *dimorphon* group are susceptible to tartar emetic. Indeed, in Zululand the tartar emetic treatment makes cattle farming again possible.

The diseases requiring *Glossina* as specific intermediary host naturally represent a source of danger only to those countries possessing that host. They are limited to Africa. In North Africa and India surra, caused by *T. evansi*, takes the place of nagana. It represents a constant formidable menace to the stock industries of all countries, since any recovered animal may act as reservoir and any biting fly as inoculator. A warning example is the experience of Mauritius in 1901, when surra, introduced by cattle imported from India, rapidly spread throughout the island and wiped out all domesticated stock. The danger is also illustrated by the importation of zebus from India into North America. Surra was there communicated to cattle, but fortunately the situation was grasped at once and the infection stamped out. South Africa and Australia have had similar experiences.

Drug treatment of surra may apparently become of practical use in infected countries, since, according to recent investigations in the Dutch Indies, the use of Bayer 205 led to recovery in quite a number of cases. This drug acts by sterilizing the blood stream, so preventing the infection of flies, which act as mechanical transmitters and not as true intermediary hosts. Eradication of the trypanosomes is possible by systematically using Bayer 205 in infected herds, at the same time destroying all animals which prove drug-resistant. An attempt in this direction is at least worthy of consideration.

TICK-BORNE DISEASES.

These comprise the second large group of importance to farmers throughout practically all warm countries, and include the following:

1. Babesidae (*Babesia bovis*, *B. bigemina*).
2. Gonderiae (*Gonderia mutans*).
3. Theileridae (*Theileria parva*).
4. Anaplasmidæ (*Anaplasma marginale* and *centrale*).
5. Spirochaetæ (*Spirochaeta theileri*).
6. An ultraviolet virus causing heartwater in cattle.

Of these tick-borne diseases, the babesioses have the widest distribution. They are now found in all five continents, Australia (Queensland) being the last to become infected. In North America the name Texas fever, in South America the name tristeza, have been used for two frequently associated diseases. One is now called babesiosis, while for the other the present writer has introduced the term "anaplasmosis." Some authorities are still uncertain about the morphological significance of the anaplasms, but investigators who know the disease from personal experience have no doubts concerning the parasitic nature of these bodies.

From an epizootic point of view, tick-borne diseases may be divided into two groups; one in which the recovered animal forms a "virus reservoir," the other in which it does not. The distinction is of particular importance wherever importation of cattle from infected countries is contemplated; especially if the importing country possesses ticks capable of propagating the disease. To this first group belong the babesioses, gonderoses, anaplasmoses, and spirochaetoses. In the second group, represented by theileriosis and African heartwater, the possibility of immune animals spreading infection is excluded, the sick animal constituting the only danger.

The problem of eradicating the tick-borne zoonoses is bound up with the destruction of the ticks, and has been practically solved by the process of dipping the cattle in arsenical baths; a method which has proved of far-reaching economic importance in Africa. In order to explain the principles underlying dipping, it is necessary to consider the life cycle of the tick, with its four stages of egg, larva, nymph, and imago or adult. Different kinds of ticks differ with regard to the number of hosts or animals upon which they feed during the three evolutionary blood-sucking stages. "One-host ticks" pass the whole cycle on one animal, engorging and moulting from larva to nymph, and then from nymph to adult, without dropping off. To this group belongs the genus *Boophilus*, the transmitter of babesiosis, anaplasmosis, and spirochaetosis. "Two-host ticks" visit two animals in completing their life-cycle, dropping off the first host for one moult before visiting the second. Of importance in this group is *Rhipicephalus evertsi*, transmitter of theileriosis, babesiosis, gonderosis, and probably anaplasmosis. "Three-host ticks" may visit three different individual animals, once as a larva, once as a nymph, and once as an adult, dropping off for each moult. This group includes the majority of ticks, the important representatives being the Rhipicephalidae, all of which act as transmitters of theileriosis, gonderosis, and to some extent of anaplasmosis and babesiosis. The European representatives are *Haemophysalis* and *Ixodes*, the former transmitting babesiosis, the latter anaplasmosis.

Amblyomma hebraeum and *Amblyomma variegatum* transmit African heartwater. In South America an *Amblyomma* is implicated in transmitting anaplasmosis.

The transmission of any particular disease may be performed by either larval, nymphal, or adult stage. In one-host ticks the infection must necessarily pass through the egg. In the two-host ticks the adults may transmit a disease acquired in the larval or nymphal stage; a fact noted in the transmission of bovine

theileriosis by *Rhipicephalus evertsi*. Three-host ticks have three chances of transmitting a disease, the case in babesiosis, gonderosis, anaplasmosis, and spirochaetosis. They are not, however, necessarily infective at all three stages, since in theileriosis and heartwater the virus does not pass through the egg.

It is of further interest to note that once a tick has become infected it need not necessarily lose its infection by subsequently feeding upon a nonsusceptible animal. Boophilus can still transmit babesiosis, and Amblyomma transmit heartwater, the former even after passing a whole generation on a refractory animal. Under similar conditions, however, the Rhipicephalidae do lose a theileriosis infection.

In arranging a system of dipping, the strength of the dip, and the intervals between successive immersions, are arranged according to the species of tick and the sojourn of its various stages upon the host. The time elapsing between the biting of the host and the loss of infection by the tick also comes into consideration. These factors determine the permissible "dipping interval;" i. e., that interval between successive immersions which will secure the stamping out of a disease in the presence of an infection. In the case of theileriosis, the tick loses its infection in from 60 to 120 hours, and hence dipping at 3 to 5 day intervals checks the spread of the disease even after the first immersion. The periods for babesiosis and anaplasmosis have not been so clearly established.

In South Africa dipping at short intervals of 4 to 7 days, or long intervals of 14 or more days, is practiced according to the object in view. The "official strengths" for arsenite solutions are 1 pound, 2 pounds, or 3 pounds of arsenite of soda per 100 gallons of tank fluid, corresponding to 0.08 per cent, 0.16 per cent, or 0.24 per cent As_2O_3 , according as a 3-day, 7-day, or 14-day interval is adopted. It has been noted that short-interval dipping not only destroys the ticks, but also saves exposed animals from infection.

Wherever systematically carried out under efficient control, dipping leads to the eradication of ticks and the disappearance of all tick-borne diseases. A larger percentage of calves are then reared, the tick-free cattle improve in condition, and in milk yield, and proper dairy exploitation becomes feasible. It is true, however, that short-interval dipping is sometimes rather severe on dairy cattle and may itself affect the milk yield adversely. For this reason the dipping interval is lengthened as soon as the tick population of the farm has been reduced to safe proportions.

Although dipping is the most universally practicable method of controlling tick-borne diseases, the same end may be achieved by "starving out" the ticks; employing a definite rotation of pasture according to the life history of the species. Still other methods involve curative drug treatment, or preventive measures based upon immunity reactions. For babesiosis, treatment with trypan blue alone or vaccination with blood of recovered animals, controlled by trypan blue injections, is effective. In the case of South African anaplasmosis, advantage is taken of the fact that recovery from the almost nonpathogenic *centrale* infection immunizes an animal against the highly pathogenic *marginale*. Cattle are therefore inoculated with *A. centrale*.

In theileriosis immunization was at one time attempted by intrajugular injection of infected lymph glands and spleen pulp, but the results were variable and the method therefore abandoned. No inoculation methods are practicable in heartwater, since the virus is so fragile that it hardly survives 24 hours' separation from the animal.

All such immunological processes should, however, be regarded only as palliative measures, permissible only where facilities for tick eradication are nonexistent, or where for various reasons cattle are required to possess immunity.

In South Africa organized dipping is actually enforced by the State only in connection with theileriosis, officially designated "East Coast fever," but the incidental eradication of other tick-borne diseases has induced progressive farmers to adopt the practice outside the proclaimed areas and a dipping tank is now part of the equipment of every well-conducted homestead.

SARCOSPORIDIOSES.

This represents a third group of protozoan infections. Sarcosporidia are parasites infecting the musculature of nearly all stock in South Africa. Their life history is still obscure, although indirect evidence suggests that they also possess an intermediate invertebrate host. Only insectivorous and herbivorous mammals are affected, the host probably being accidentally ingested with the pasture in the case of cattle. Their pathogenic importance has been much exaggerated, and all attempts to correlate their presence in the muscles with specific disease have failed in South Africa. There is, however, some evidence that a very heavy infection of heart and skeletal muscle may lead to general disturbance of health in cattle, manifested by general anemia and hydremia. It also appears that pastured animals suffer more than stable cattle and it is therefore likely that with increasing intensity of dairy husbandry sarcosporidiosis will diminish.

COCCIDIOSES.

This last group of protozoan diseases is probably of world-wide distribution, although more localized than any other group. Catarrhal fever of East Africa has been reported as caused by *Coccidia*, but does not correspond completely with the similar disease of Europe. The analogous disease of America also shows certain differences in epizootological features, and hence it seems probable that different species of *Coccidia* are involved in different countries. At any rate there is abundant scope for further research.

The transmission of coccidiosis can be explained as simply due to the ingestion of foodstuffs soiled with the oocyst resting stage, but in considering the enzootology of the disease, and the fact that the hosts of *Coccidia* are generally invertebrates, it seems possible that coccidiosis in cattle is merely an accidental disease, the organisms being maintained and propagated in the pasture by purely invertebrate hosts.

Coccidiosis in cattle is not a deadly disease, the damage arising mainly in loss of flesh and milk. No specific treatment has been devised, and good nursing is apparently all that is required. Its prevention can be assured by stabling, or by draining of the land. In tropical countries where this is not feasible, but where large areas are at disposal, change of pasture may effect improvement. Since adult cattle suffer much less than younger cattle, the existence of immunity must be assumed, and preventive inoculation has therefore some prospect.

STATE CONTROL.

The control of protozoan diseases should be considered primarily from the point of view of the State. Of first importance is the regulation of movement of stock from infected to uninfected countries. In most protozoonoses bovines can act as reservoirs and set up new infections wherever they go, several species of biting flies spreading the disease by mechanical transmission in the absence of specific vectors. The movement of cattle or other stock liable to harbor trypanosomes should therefore only be allowed after exonerating suspects.

In the same way, cattle bred in tick-infested countries are liable to carry tick-borne diseases in their blood. Wherever ticks exist there is always the potential danger of infecting them and so establishing the disease. Unless, therefore, it is certain that any particular disease is not carried by cattle (theileriosis and heartwater) or that no tick capable of acting as vector is present, no suspect should be introduced. Such precautions have been recently adopted with success in some countries threatened by invasion.

Wherever the formidable protozoonoses already exist it is the duty of the State to eradicate them, and wherever methods are not satisfactory it is the business of the State to organize researches. In the trypanosomoses, with specific obligatory hosts, the line of attack should be naturally directed upon the latter. Where transmission is by nonspecific vector, drug treatment, combined with destruction of drug-resistant individuals, is indicated.

In the case of all tick-borne diseases, institution of compulsory dipping is the most promising direction of State action. Coccidiosis does not appear to carry international dangers and there is therefore no urgent need of State interference. The individual owner can usually be left to take individual precautions, such as avoidance of utilization of green food off infected farms.

In the last resort, the final control is always in the hands of the individual farmer; and although much depends upon his own energy and sagacity, it is the educational function of the State to place at his disposal all information concerning the nature and prevention of all diseases he may encounter.

Chairman KLEIN. We have just heard within a brief space of time a very authoritative discussion of a group of diseases in which the speaker has been a very active and a very successful investigator. Is there anyone who would like to discuss this subject further?

The speaker has evidently covered the ground so thoroughly that there is nothing left to be said, and so we will pass on to the next paper, "Diseases of the digestive system of cattle," by Dr. D. H. Udall, in charge of the ambulatory clinic, Cornell University.

DISEASES OF THE DIGESTIVE SYSTEM OF CATTLE.

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The digestive system of cattle is subject to a wide variety of maladies in animals of every age. According to Hess (Bern), it is the seat of about one-fourth of all diseases of bovines. It is the portal of entry for the causes of many affections. These causes may limit their attack to this particular system, or they may pass on to other organs. Various general infections pour their causative micro-organisms from the circulation into the tissues and contents of the alimentary tract. Thus it is not only one of the chief portals of entry, but it is also one of the main distributors of disease. This paper will deal largely with the occurrence, etiology, and prevention, rather than with symptoms and treatment.

INDIGESTION.

Indigestion is a derangement of the normal functions of the stomach or intestines. It is chiefly a disturbance of the mechanical and chemical preparation of the food for absorption by the mucous membranes. Severe forms lead to serious inflammations of the alimentary tissues, and to fatal intoxications. Among calves it takes a heavy toll. Many cases of white scours are primarily indigestion. Newborn calves enter upon an artificial existence. The milk of the dam immediately after parturition is abundant and rich. The development of the digestive organs of the fetus has not kept pace with the udder development of the modern dairy cow. An overloaded stomach gives rise to abnormal decomposition of its contents, which leads to the absorption of infective and toxic material into the circulation. The economic loss from death or retarded growth is high. What is the prevention?

A few years ago Doctor Frost discussed the question of disease among calves and the value of carbonate of soda in the treatment of white scours. Limewater is used for the same purpose. I believe the effect is the same in the control of hyperacidity.

This method is not offered as a substitute for the control of definite infectious disease in newborn calves. But I believe that many cases have been attributed to infection when the basic trouble was dietetic.

Theobald Smith and his coworkers at Rockefeller Institute have proved the definite value of colostrum as a protective agency in the newborn. Most calves receive this colostrum naturally. Associated with their work was another discovery—perhaps not a discovery—but a restatement of a known fact that the infection to which the newborn succumb was largely the colon bacillus, an organism that is normally not pathogenic to the young.

My theory with reference to milk is that the effect of the ingestion of too much milk at an early stage is to cause an indigestion which

tends to induce a gastritis in all animals, and in newborn animals, very susceptible to disease, it is often the determining factor in establishing what is commonly called "white scours"; or they may die of septicemia. The animals are taken sick within 24 to 48 hours, and die in a short time. The post-mortem will show all the changes in septicemia.

Along with this feeding, we have given the animals normal cow serum for the reason that it was found at the Rockefeller Institute to protect calves and to be a substitute for colostrum. This was given intravenously to a few, but it was found not to be satisfactory. Some calves would collapse and nearly die within 20 minutes.

An examination of the milk of a Guernsey cow about the thirtieth hour after freshening, reveals in the cases we have examined only a small column of what appears to be milk. The rest appears to be fat. Whether it is all fat I don't know, but the percentage is certainly high. That is a point to be determined; but assuming that apparent fat is fat, and the calf receives an unlimited amount when it is very young and ravenously hungry, it is well within the realm of probability that it alone is sufficient to cause death. I believe that much of the so-called "white scours" and infection of newborn animals may be prevented by proper housing and diet.

Usually the newborn arrive in a healthy condition. Few are handicapped by disease acquired in utero. Often the cause of death enters the mouth cavity shortly after birth in the form of an oversupply of milk. The following method of care and feeding during the first month is of proved value in the reduction of deaths in newborn calves:

1. Allow the calf to remain with its dam for the first 12 hours. This provides colostrum, but does not permit overeating.

2. On the second day, withhold all milk unless the calf shows evidence of great hunger, when it may receive 8 ounces each of its dam's milk and limewater at body temperature.

3. On the third day, feed 4 to 5 per cent of the body weight of the dam's milk mixed with an equal amount of limewater at 100° F.

4. At the end of the first week the calf may receive 8 to 12 per cent of its body weight of milk; by the end of the second week this may be brought up to 10 to 14 per cent of the body weight. Feed morning, noon, and night, each feed containing a pound of limewater. Warm the milk to 100° F., and feed in individual pails. After feeding, rinse the pail in clean water, and scald it in steam under pressure, or boil a small amount of water in it for two to five minutes. During the first week, before the noon feed, take the temperature. If it is 103° F., or more, give an enema and 3 ounces of liquid petrolatum, and withhold feed until the temperature is normal and the calf ravenously hungry. At birth give 3 ounces of liquid petrolatum to a 70 pound calf.

Housing conditions should protect calves against extreme cold, sudden changes in temperature, and cold drafts from open doors. They should be kept dry, warm, and clean. Each calf should be provided with an individual pen. Each calf should wear a muzzle until 1 month of age; this prevents ingestion of filth and indigestible substances such as straw or shavings. Normal healthy calves will lick and swallow any substance within reach. A small handful

of straw or other foreign material in the stomach retards digestion and growth, and often is a direct cause of death.

Among cows indigestion is the most frequent primary disease of the alimentary tract. The mortality is low. Fatalities occur chiefly in herds of poor or careless owners. Their animals more readily gain access to grain bins, frozen grass, newly threshed grain, fields of luxuriant roughage, heated or moldy fresh silage or hay, spoiled food, etc. Cows kept under a regular régime, even when fed heavily, are less subject to indigestion. Herd managers recognize the disease early, food is withdrawn, the bowels are evacuated, and recovery is usually prompt. Most indigestions occur in seasons when the food is changed from old to a new crop, or when for several months fibrous roughage constitutes the main part of the diet.

The symptoms of indigestion in cows are dullness, fever, diminished appetite and milk secretion. The contractions of the rumen and rumination are irregular or suspended. The bowel evacuations are suppressed. When all diet is withheld and laxatives are administered, the usual course is two to four days, terminating in recovery. Severe types due to accidental overeating often terminate in a fatal gastroenteritis.

The prevention of indigestion in cows is comparatively easy. Under normal conditions they readily digest an enormous amount of food. Digestion and assimilation are their strong characteristics. Herd managers who provide a reasonable variety of dry and succulent roughage as well as grain, and who feed regularly, have little to fear from this disease. While indigestion in cows is frequent, it does not constitute an important economic problem. It is associated chiefly with a low type of animal husbandry. Changes in food or feeding should be gradual. Animals in transit should be fed and watered regularly; at destination they are often fatigued, so that food and water should be somewhat restricted for the first 24 hours.

TRAUMATIC GASTRITIS.

Pointed metal objects such as wires, small nails, and pins are often swallowed by cattle. These reach the manger in grain or roughage, or they may be picked up in pastures where wire fencing is used. Among all affections of the digestive system, traumatic injuries from such objects cause the greatest loss. It has been estimated that on certain farms in California, deaths from this cause exceed those of all others combined. An abundant European literature on the subject indicates a universal distribution. The heaviest losses are on farms where building construction or repairs have been recently conducted. In this country, since the use of wood and string has been supplanted to a considerable extent by wire, and old-fashioned blunt nails by sharp ones, the fatalities appear to have increased. Many mature cows of to-day carry material in their stomachs capable of destroying life. These injuries result in a local inflammation from which the animal may recover, after what is usually diagnosed as a severe attack of indigestion. Such cases result in a circumscribed adhesive chronic peritonitis between the reticulum and diaphragm and to some extent in other abdominal

viscera. This may cause no further trouble. But in many cases the infection spreads during advanced pregnancy or following parturition; the sharp body extends the fistulous tract, inducing serious and extensive injury in adjacent organs. The loss from traumatic gastritis is not measured alone by the deaths of which it is the direct cause, though these place it well at the head of the list of digestive fatalities. Often it occurs that a cow, apparently dead of some other affection, such as metritis or mastitis, will, on autopsy, reveal a more or less well-marked traumatic gastritis. The cow might have survived had she suffered from either disease singly, but the combination proved fatal.

About half of such injuries are confined to the abdominal organs; the other half extend into the thorax, affecting chiefly the heart. The clinical characteristics are as follows: During advanced pregnancy, or shortly thereafter, the cow develops symptoms of indigestion. Often the course extends to 10 days or more, two or three times that of primary indigestion, to an apparent recovery. The symptoms are intense in most cases. Loss of appetite and milk secretion is sudden and complete. There is a tendency for the sick animal to remain down; she is reluctant to rise or move about. Pressure behind the elbow may cause severe pain. When the heart is affected, the pulse rate is high, and the heart sounds are abnormal. Recovery may occur only to be followed by a second or third attack within the year.

Notwithstanding the fact that prevention is simple, this disease continues to furnish more autopsies to the average veterinarian in dairy districts than any other single disease. Since wires head the list of causes, their source requires careful watching. Where baled hay is fed, a systematic method of removal of wire is desirable. The same is true of wires attached to grain sacks. Pastures inclosed with woven-wire fence are especially dangerous when the wire disintegrates. In one of our patients, 19 such pieces were found in a single heart sac. Rubbish in cattle yards, lanes, and pastures should be prohibited; it not only harbors wires and nails, but paint pails and other poisons. Nails dropped into a silo during its construction may easily cost more than the silo itself. Keep cattle at a distance from buildings under repair. No practical method of treating this disease has been discovered.

INFLAMMATION OF THE STOMACH AND INTESTINES.

In addition to inflammations caused by sharp metal objects, the digestive system is often the seat of bacterial infection. It may be specific or nonspecific. It may be mild, gastrointestinal catarrh, or severe gastroenteritis.

Nonspecific inflammations usually have a dietetic origin. A simple neglected indigestion may lead to a fatal involvement of the stomach and intestines, or the food may be of such a character that it immediately causes severe inflammation. Such affections are frequent in the young. Calves are predisposed by the feeding of milk substitutes, feeding at irregular intervals, overfeeding, poor quality of food (cold, filthy, sour), the use of filthy pails or troughs, or failure to withhold food when the animal sickens. Further predisposing causes are found in exposure to moisture and filth. The com-

mon saying, that "calves will not thrive unless their feet are kept dry," has reference to affections of the digestive system. Fatigue, especially when combined with hunger, as observed after transportation, is a very potent factor. When such animals are allowed a liberal amount of food and water on reaching destination, a rapidly fatal enteritis is liable to develop. Often the bacterial cause is present in the food at the time of ingestion. Such food has usually undergone partial decomposition, or it has been damaged by heating, freezing, etc. Especially dangerous is moldy heated silage from the top of a recently filled silo.

The symptoms vary widely. In the mature, dietetic irregularities, leading to bowel catarrh and more serious inflammations, have a history of one to three days of dullness, inappetence, and diarrhea. The feces are dark, fetid, sometimes mixed with blood. In severe types the onset is painful and sudden, soon leading to trembling and collapse; this type suggests an intoxication or infection as the dominant influence. Fever is rarely present. The pulse is high. The digestive system is paralyzed.

Specific inflammations are observed in anthrax, hemorrhagic septicemia, necrobacillosis, Johne's disease, and coccidiosis. In winter dysentery in cows, and in occasional enzootics of diarrhea in young animals, the disease is known to be purely infectious, but the causative bacteria have not been recognized.

Certain infections of the digestive system merit special consideration. In general infections, like anthrax and hemorrhagic septicemia, the digestive symptoms and lesions constitute only a part of the clinical and post-mortem appearances. The following specific infections limit their activities to the bowels:

JOHNE'S DISEASE.

This is a chronic inflammation of the intestinal mucosa characterized by emaciation and diarrhea. It usually terminates in death. It is caused by a microorganism that is similar in appearance to the tubercle bacillus.

Twort and Ingram¹ report that the disease is very prevalent in England, where it exists in almost every county. They regard 1 per cent as a low estimate among milk cows. In the United States the disease was first discovered in Pennsylvania in 1908. Beach and Hastings² have found it in 18 herds in Wisconsin. They state that "the prevalence of the disease is not such as to cause great alarm, except that it is likely to be present in purebred herds from which animals are being sold in great numbers. A few such distributing centers may in a few years infect many herds, and the disease will thus spread with a constantly increasing rapidity unless more attention is paid to it than is done at present."

CONTROL.

Since the disease is incurable, and finally leads to death, chief interest is centered in prevention. The symptoms are gradual emaciation, extending over months, regardless of sufficient food and a

¹ Monograph on Johne's Disease. 1913.

² Johne's disease, a cattle menace. Wis. Bul. 343. 1922.

good appetite. At intervals affected animals develop diarrhea. Finally this becomes a permanent condition. At last such patients are usually slaughtered, when the disease may be positively diagnosed by finding the characteristic lesions and bacteria. In the meantime others have become infected. This method of recognition and removal is too slow. Recently there has come into diagnostic use a product of the growth of the causative organism. This is analogous to tuberculin and is termed Johnin. The test is similar to the tuberculin test. Preinjection temperatures are recorded. The appropriate dose is injected into the vein, and postinjection temperatures are immediately taken. Infected animals respond with a rise in temperature. While this method of diagnosis has not been used extensively, it seems to offer the only method of detecting the disease before it has spread to others.

COCCIDIOSIS (RED DYSENTERY)

Coccidiosis is a superficial inflammation of the mucosa of the large intestine, chiefly the rectum. It is caused by a protozoan of the genus *Coccidium*.

In the United States, descriptions of this malady are of recent origin. Apparently it has had a widespread, but unrecognized existence. It has been reported from various parts of the United States. According to Hess it has been recognized in Switzerland since 1890, where it is a common summer and pasture disease, especially at high elevations. Numerous cases among young cattle have been observed in the ambulatory clinic of the New York State Veterinary College. Here, likewise, it has been chiefly observed as a pasture disease on high wet farms.

Infection is acquired in the food and water. The onset of the disease is sudden. It is marked by weakness, rapid loss of flesh, and bloody diarrhea. The bowel evacuations may consist entirely of blood clots. Often several in the same herd are affected. The mortality is high, and the course from 2 to 10 days. No satisfactory treatment has been discovered. Infected pastures may be abandoned until drained.

IMPORTANCE OF THE DIGESTIVE SYSTEM AS A PORT OF ENTRY OF DISEASE.

The digestive system is a port of entry of the causes of many diseases, in which it either remains normal or is involved only in a partial or occasional manifestation. Control of some of our most destructive maladies depends on guarding this channel of invasion. For years the importance of preventing infection from drinking and feeding utensils has been emphasized in human hygiene. To a very limited extent this practice has been adopted by owners of cattle. Experience has shown that direct passage of the tubercle bacillus from the manger of the affected cow to the mouth of the healthy cow is one of the chief and most obscure sources of infection; and that even an inexpensive so-called insanitary, wooden manger will prevent much of this extension. More regard for control of possible infection at its port of entry to the animal may prove to be an essential in the satisfactory control of disease. Disregard

of such sources has frequently resulted in costly failure. In 1922 the finance committee of the United States Livestock Sanitary Association, referring to tuberculosis control, said:

Sanitation, individual drinking cups, and Pasteurized milk for calves are factors that in the majority of instances are absolutely essential in the control of this disease. It is thought by many that if the State would appropriate for a campaign of education that would employ the most efficient men available, not to exceed one-half the amount at present appropriated for indemnities, in a short time greater results would be accomplished.

It is generally believed that Bang abortion disease is largely acquired through the digestive system. If this theory proves to be true, it will be another reason for protecting the manger against contamination from the gutter.

The extent of the spread of infection and disease from mangers and stagnant water holes or troughs can not be estimated. Our knowledge of the causes and nature of disease is far from complete. It is a common experience with every veterinarian to encounter fatal diseases in cows, in which the causes of death, even with the aid of a modern laboratory, remain unknown.

Consideration of disease agencies that are known to enter through the mouth, not to mention those that are unknown, is sufficient to justify an increased regard for sanitary methods of feeding and watering. Modern stables that present an ideal condition with reference to light, ventilation, and cleanliness, often harbor a high rate of disease. In such stables economy in feeding and watering have often been obtained at a sacrifice of the fundamentals of hygiene. Good stable hygiene means more than light, ventilation and cleanliness. In the human family tuberculosis is a filth disease. Among bovines it flourishes where cleanliness is emphasized.

Prevention of diseases of the digestive system, as well as prevention of infection that enters through this channel, may be partially accomplished by providing an individual manger for each cow, or each group of two cows. Such mangers should be designed to prevent fecal contamination from the feeding floor and other sources. Refuse from mangers should not be returned to the feeding alley. Objections have been raised to this type of construction. Dairy inspectors sometimes state that it interferes with frequent washing, and that individual mangers are less readily cleaned. In reply it may be stated that the washing or flushing of common mangers has been one of the chief recent contributions to the spread of tuberculosis among dairy cows. Eradication of bovine tuberculosis is regarded by health officials in the light of a public health measure. In view of this fact, it is difficult to comprehend regulations that contribute to its spread among cows. Daily washing of mangers is unnecessary, and flushing of common mangers is highly insanitary. In this manner saliva of infected cows is transported to others. The chief objection from owners is the increased cost of construction, and the increased time required to place the food in the mangers and to remove the refuse.

Chairman KLEIN. Doctor Udall has succeeded in presenting a great deal of information in a very limited space of time. Some of the diseases which he has discussed are frequently met with by

dairymen and perhaps some of those present may desire to enter into some discussion on this subject. If anyone wishes to discuss any part of this topic we will be very glad to hear from him.

There is no one, apparently, who desires to say anything on this matter, so we will pass on to the next topic, "Bovine mastitis," by Dr. F. S. Jones, pathologist, Rockefeller Institute. Doctor Jones.

BOVINE MASTITIS.

FREDERIC S. JONES, V. M. D., pathologist, Rockefeller Institute, Princeton, N. J.

It hardly seems necessary for me to call your attention to the economic importance of mastitis.

Mastitis is one of the more important diseases affecting cows. In diseases which involve the udder, secretion is decreased, or entirely suppressed, and in most instances the milk is rendered unfit for human consumption. The rigid requirements in operation for the production of certified milk in certain localities necessitate the removal of cows suffering from mastitis from the milking line.

A considerable number of forms of udder disease exist. Among the more important may be mentioned the localization within the mammary gland of foci of general disease processes, such as in tuberculosis. Injuries to the skin and underlying mammary structures may lead to invasion of bacteria, resulting in a widespread tissue destruction. Such processes are usually referred to as "phlegmonous" in character.

While diseases due to such agents are not uncommon, the most frequent types of inflammation are due to invasion of the udder by way of the teat canals by several varieties of pathogenic organisms. Of greatest interest to the dairymen are the severe acute involvements of the secreting tissues of one or more quarters, and the slower, less marked inflammation of the milk ducts, cistern, and teat canals. To the former the name acute, parenchymatous mastitis is applied; the latter is defined as catarrhal mastitis.

SYMPTOMS.

In many cases of parenchymatous inflammation, one or more quarters are suddenly affected. The cow refuses food. There is fever. The involved portions of the mammary gland are swollen, and the overlying skin may be reddened. The visible blood vessels are distended. The quarter is hot, firm, and tender. Milking causes considerable discomfort at first, but as pressure is relieved the cow becomes more docile. The secretion early in the disease is often watery and contains irregular, coarse flocculi. The reaction is alkaline. As the disease progresses, the character of the secretion changes. Often it becomes thick and distinctly yellow in color. On standing, the flocculi settle, leaving an opaque, serous, supernatant fluid. The secretion coagulates on boiling. Its reaction is alkaline.

Microscopic examination of films prepared from the sediment of the centrifuged secretion reveals polymorphonuclear leucocytes and the causative organism in large numbers. For bacteriological examinations, the best results are obtained when milk is drawn directly from the udder into sterile bottles and examined as soon as possible.

Usually the milk is diluted with salt solution, and definite amounts of the mixture added to melted agar containing about 8 per cent of defibrinated blood, and the whole poured into petri dishes. In this way an adequate idea of the total number and kinds of organisms per cubic centimeter of milk is obtained.

The inflammation may subside gradually, the involved portions become softer, and the secretion finally becomes normal. The process may have been of such severity that a large portion of the secreting tissue has been destroyed. In such cases, the quarter shrinks in size and becomes firmer. The firmness is due to the decrease of the glandular elements and an increase of the interstitial (fibrous) tissue.

Klein (1) considers that catarrhal mastitis occurs more frequently than any of the other forms, and attributes considerable loss to cases of this nature. In this type there is no apparent swelling of the quarter. The milk appears normal except for a few tiny flakes. Often the affected quarter is difficult to milk. The walls of the teat canal are appreciably thickened. Firm nodules in the walls of the milk cistern are not uncommon. Klein points out that the sub-mucous tissues may become involved, resulting in well-defined indurations.

ETIOLOGY.

During the past 30 years, a number of workers have undertaken the study of the organisms associated with udder infection. Nocard and Mollereau (2) made bacteriological examinations of 10 cows suffering from contagious mammitis. From all they obtained streptococci. Lucet (3) examined the secretions from 21 cases; 12 were infected with a rod-like organism, probably *B. coli*, 7 with micrococci, and 2 with streptococci. Guillebeau (4) observed 85 cases. Of these, 52 were associated with micrococci of various kinds, 22 with *B. coli*, and 11 with streptococci. Steiger (5) made bacteriological examinations of 45 cases in cows and 1 in a goat. Of these, 16 were attributed to micrococci, 10 to streptococci, 14 to *B. coli*, and 6 were mixed infections of *B. coli*, streptococci, etc. Savage (6) reported the bacteriological findings in 31 instances; 21 were due to streptococci, 5 to micrococci, 1 to *B. coli*, the tubercle bacillus was found in 1, and 3 others were of doubtful origin. Zwick and Weichel (7) obtained *B. lactis aerogenes* from 19 cows suffering from mastitis. From 2 other udders they isolated paratyphoid bacilli. Gilruth and MacDonald (8) reported a severe outbreak associated with *B. lactis aerogenes*. Ward (9) cultivated *B. pyogenes* from udder lesions.

The writer (10) undertook the study of mastitis, and from 81 cases the following results were obtained:

Associated with—

nonhemolytic streptococci	31
hemolytic streptococci	17
mixed hemolytic and nonhemolytic streptococci	2
micrococci	24
<i>B. coli</i>	2
<i>B. pyogenes</i>	2
pleomorphic gram-positive rods	2
<i>B. lactis aerogenes</i>	1

The cases attributed to streptococci were severe. Of 27 followed for a considerable period, 8 recovered. The others either lost the function of the involved quarters, or the disease progressed to such an extent that they were no longer profitable as milk producers. The infection associated with micrococci were as a rule milder, but a few of considerable severity were recorded.

METHODS OF INFECTION.

Bacteria may gain entrance into the udder through at least three well-recognized channels. Metastasis may take place from other organs, as in tuberculosis. The organisms encountered in the widespread phlegmonous inflammations of the mammary tissue are usually introduced by the penetration of sharp objects through the skin or by other injuries.

In catarrhal and parenchymatous mastitis, infection appears to take place through the teat canal. Actually how the organisms in natural infection gain access is still problematical. Observations by the writer (11) assist in throwing some light on the problem. The hands of a milker which had been soiled with milk during milking were examined bacteriologically. Hemolytic streptococci, similar to those obtained in udder milk, were obtained from them while they were still wet with milk, and after they had been washed in cold water and dried on a clean towel.

Certain milkers brush off the teats with the palm of the hand before milking, and it is possible that the ends of the teats may be contaminated with bacteria in this way. A dangerous but common practice is to milk an involved quarter on the floor where the secretion may soil the bedding of adjacent cows. The indiscriminate use of improperly sterilized teat tubes affords a ready source of transmission.

Mastitis has been produced by a number of workers, by the injection of fluids containing bacteria into the teat canals. The recent experiments of Carpenter (12) in this connection are of considerable interest. He showed that injections into the teat canals of milk containing streptococci from infected udders resulted in a more severe mastitis than the introduction of broth cultures of the same organisms. Inoculations of culture of *B. abortus*, streptococci obtained from the ovary and uterus, and *B. pyocyaneus* gave rise to mild transitory reactions. *B. coli*, on the other hand, produced an acute mastitis. *Staphylococcus aureus* and *B. bovisepeticus* produced severe lesions and destroyed the functional activity of the gland.

SOURCES OF INFECTION.

During the writer's studies of mastitis, many cases occurred which had apparently no connection with each other. It was recognized that clinical cases were ready sources of infection. It was also known that, in addition to the affected quarter, one or more of the others may harbor the causative organism. The organism may also persist in the udder after apparent recovery. In a few instances, it was possible to examine the milk shortly after spontaneous infection. The udder was apparently normal, and the milk showed no abnormalities.

The organisms increased from day to day, and finally clinical manifestations developed. The udder, during the period of incubation, may then afford another source of infection. With these known sources of infection, the explanation of the great incidence of udder disease in the herd was still obscure.

Williams (13) suggested that mastitis may follow genital infection. Hagan (14), in examining the placentas of cows, encountered streptococci in a number of instances. It was assumed that during parturition or uterine disease the discharges containing these organisms came in contact with the teats and resulted in infection.

In order to establish all possible sources of infection (11), and perhaps in this way explain the irregular occurrence of the disease, a series of observations was made. Examination of the skin, saliva, and feces of cows revealed streptococci of markedly different characters than those found in mastitis. The vagina of 50 cows, and the uterine discharges of a considerable number of others, revealed in only two instances streptococci similar to those found in mastitis. Several well-defined types of streptococci, differing in many respects from the udder forms, were found in the genital tract. These areas, then, were not the common source of mastitis streptococci.

Further light was thrown on the problem when a systematic examination was made of the udder milk of the 50 cows in one barn. The incidence of mastitis in this barn had been high. The milk of 16 cows was found to contain either hemolytic or non-hemolytic streptococci. The organisms were culturally and serologically identical with those previously obtained from clinical cases. Of these 16 cows, 3 developed mastitis while under observation, 5 had suffered from mastitis during the lactation period, but the milk of the remaining 8 had never been rejected because of udder inflammation. The fact that the organisms can establish themselves in the apparently normal udder is of considerable importance.

To summarize, the principal source of streptococcic infection, aside from the clinical cases, is apparently normal cows which carry the virus in the udder. These carriers may be grouped as follows: (a) Those that have been infected recently and have not yet developed symptoms; (b) those that have suffered from inflammation of the udder and still harbor streptococci; and (c) those that have no clinical history of mastitis:

While the number of carriers observed was high, it must be borne in mind that in this herd udder disease is frequent, and the barn in which the greatest number of cases occurred was chosen for these observations. In connection with other work, many examinations of the milk from individual cows in other barns have been made. On the whole, the number of udder infections was a little lower, but the udders of at least 10 per cent of the cows in this herd harbor mastitis streptococci. Examinations of the bottled milk bear out these findings. During 1919 (15), a good many samples of the bottled milk were examined. The average bacterial count was 2,850 organisms per cubic centimeter, of which 15.5 per cent were mastitis streptococci.

The irregularity of the occurrence of mammitis is explicable, at least in part, by transmission by the milkers from the various types of carriers. On this farm the "gang system" is employed. Each

milker is assigned a cow, and after milking he washes his hands with soap and cold water, and dries them on a fresh towel. He is then assigned another cow. In this way one man milks two or three cows irregularly spaced in each barn.

The movement of carriers to various positions in the barns and to other barns would also tend to expose new cows.

The writer believes that the rôle of injury in the production of mastitis has been practically nil in the cases under his observation. If injuries occurred, they were of such a nature that they could not be detected. It is said that high grain rations may cause mastitis. That high grain rations and the conditions attendant to heavy milk production may render cows susceptible is admitted, but that udder inflammations occur without infection is doubtful. Incomplete milking may be of importance. It is possible that milk left in the larger milk ducts, cistern, and teat canal affords an excellent culture medium for organisms gaining entrance through the teat canal. Further experimentation and observation are necessary to prove what factors other than infection are essential to udder disease.

ASPECTS OF THE MASTITIS PROBLEM OF IMPORTANCE TO THOSE CONCERNED WITH PUBLIC HEALTH.

Most States or communities prohibit the sale of milk from sick or diseased cows. The milk from cows suffering from udder disease should, of course, be excluded from the milk supply. There exist, however, no facts to support the view that a moderate number of streptococci, identical with those found in mastitis, are pathogenic for consumers of raw milk. The observations, cited in the case of the market milk containing on the average over 400 mastitis streptococci per cubic centimeter, are ample to prove this point. This milk is uniformly high in quality. Diseases traceable to the milk supply have not been reported among the consumers.

There can, however, be no question that certain well-defined epidemics of sore throat are attributable to an infection of the milk supply. The observations of Savage in England, Davis and Capps (16), Smith and Brown (17), and Brown and Orcutt (18), in this country, have thrown considerable light on the origin of some of these milk-borne epidemics. In certain instances human streptococci, probably from the attendants, gain entrance to the udder. They multiply within the udder and are shed in the milk. Such streptococci are dangerous to the consumers of milk. Streptococci of the human type (*Streptococcus epidemicus*) have been shown by Avery and Cullen (19), Brown (20), Jones (21), and others to possess certain well-defined characters which differentiate them from those of bovine origin. The experiments of Davis and Capps showed that human streptococci, introduced into the udder by way of the teat canal, led only to a mild reaction. The organisms, however, persisted in the milk for a considerable period. The cow infected with *Streptococcus epidemicus*, in Brown and Orcutt's study, evidently suffered from a progressive mastitis. The character of the secretion from the affected quarter was abnormal. The writer inoculated one quarter of the udder of a normal cow with milk from this cow. Within 24 hours the quarter was swollen and the milk of a distinct

yellow color. Characteristic acute parenchymatous mastitis developed. The condition became chronic and secretory function lessened. *Streptococcus epidemicus* was present in large numbers in the abnormal secretion from this quarter for a period of several months. The organisms persisted in the milk from the inoculated quarter until the cow was killed.

Fortunately, udder infection with the human organism is relatively uncommon; nevertheless, such infections are liable to occur at any time. In herds producing raw milk the rejection of milk from all cases of udder disease is essential, until definite proof is furnished that they are not associated with streptococci pathogenic for man.

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Chairman KLEIN. Since the next paper is on the same subject, mastitis, with the consent of those present, we will postpone the discussion of Doctor Jones's paper until after we have heard from Doctor Frost. Dr. J. N. Frost, professor of surgery, New York State Veterinary College, Cornell University, will now read his paper on mastitis. [Applause.]

Dr. J. N. FROST. Ladies and gentlemen: Since this subject is the same as that of Doctor Jones, there will naturally be some repetition, but we will try to limit that as much as possible.

MASTITIS.

JAMES NATHAN FROST, D. V. M., professor of surgery, New York State Veterinary College, Cornell University, Ithaca, N. Y.

Mastitis, or inflammation of the udder, is also known as mammitis, and when the udder becomes hard, is commonly called "caked udder"; or if the milk contains thick particles, it is known as "garget." Inflammation of the udder is extremely important to the dairyman.

The more select product he attempts to produce, the more important becomes the udder trouble. With a larger development of the udder, which has been brought about by better breeding and feeding to increase production, there is a tendency for the udder trouble to increase. With the increased size of the udder has come a better blood supply, a better nourished gland and one more easily congested; also, a larger milk cistern and generally a larger teat orifice, all of which are conducive to the production of inflammation of the organ. The situation of the udder so near to the excretory end of the intestinal, genital, and urinary tracts increases the amount of filth which comes in contact with the udder and favors infection.

The udder is a secreting gland made up of the parenchyma or secreting part, the connecting or interstitial framework, and the milk cistern. The parenchyma or secreting part is formed of many small canals lined with a single layer of epithelium. These canals unite to form larger canals, finally emptying into the still larger milk cistern or reservoir, which, in turn, may be emptied by suction or pressure on the teat canal. The canals of the parenchyma or secreting part are surrounded by the interstitial connective tissue, which contains the nerves, blood vessels, and lymph spaces that supply the parenchyma with material from which to secrete milk. The secretion of milk usually commences with the termination of first pregnancy or abortion, though occasionally one sees a virgin heifer giving milk. The active secretion is stimulated by the sucking of the young or by the massage of the milker.

CAUSE.

The cause of mammary inflammation may be mechanical, chemical, thermal, or infectious; or a combination of the infectious with any of the other three.

Under mechanical causes may be given the injuries which are produced by being trod on by a neighboring cow; wounds produced by the sharp dewclaws, especially about the time of parturition when the animal is heavy and uncertain in rising and when the udder has reached its greatest size; also those injuries which are produced by horns or wires when the animal is in paddock or pasture.

Chemical irritants, unless used by mistake, are seldom the cause of inflammation except possibly fly spray which is used too strong.

Thermal irritants are not common except in a cow driven long distances through the snow, when the teats may become frozen.

The principal cause of mastitis is infection, with the other causes that are usually given acting as predisposing factors. Cold floors, high protein feed, and bagging up, which is done before sales or shows (which many claim will produce mastitis), may, by lowering the resistance of the udder, give the infection a better chance to develop. Changing from a low-protein diet to a high-protein diet causes congestion and lowered resistance of the udder. Cases have been observed of mastitis, aggravated by change of the diet in poor cows suddenly placed on heavy feed; while other cases, with the gradual increase in diet, in place of the sudden change, have not shown the same irritation. We have attempted to develop mastitis

by feeding cottonseed meal and gluten, but have been unsuccessful unless there is a high bacterial infection of the udder.

The infection most often enters the udder up through the teat canal and milk cistern. It may, however, enter through an abrasion or wound of the skin of the teat or udder, or by metastasis, through the blood or lymph streams directly to the secreting tissue.

The source of the infection is most likely the discharge from a retained membrane, infected genital tract, a case of fowls, or dirty stable floors and filthy, muddy paddocks through which the animal must wade to reach the stable. The watery exudate from a true or so-called cowpox pustule, discharged down over the end of the teat, may easily be carried into the milk cistern to cause an irritation and infection there. Chapped teats, due to washing and not drying, or to wet milking in a cold stable, as well as wounds and abscesses in the region of the udder, may be the source of the purulent material coming in contact with the teat.

The use of milking tubes, plugs, quills, cloves, and the like material in the teat by an inexperienced attendant is almost sure to result in infection, unless he has been thoroughly instructed in the care necessary in the disinfection and use of these instruments.

Metastasis, or infection through the blood stream from an infected or diseased uterus, is sometimes the cause of trouble, and is especially likely to result in a purulent or gangrenous form of mastitis. To these causes may be added tuberculosis, actinomycosis, and necrobacillosis and specific infection of the udder.

SYMPTOMS

The first stage of lactation is usually accompanied by edema of the udder, which is not a true inflammation, although it may be difficult to draw a line between that and the true inflammatory edema. This edema is seen particularly in heifers and heavy milkers, and by some is considered a sign of a good dairy animal. It often appears as a soft, flabby swelling a foot or more in diameter, just anterior to the udder, and has been mistaken for a rupture or other severe pathological condition. It may extend on the posterior side of the udder, up as far as the vulva and roof of the tail. This edema should not be considered as serious, since it soon disappears without treatment after parturition and the drawing of the milk from the udder.

While mastitis is more common at the time of parturition with the accompanying edema and congestion of the udder, still it is too commonly considered a disease of the fresh cow only. The discharges from a normal parturition, together with those which accompany retained placenta and metritis, increase the percentage of cases occurring at this time.

Mastitis is a disease which may attack the calf soon after birth, before the udder has developed to any size. It may appear at any time during or before the lactation period or even after the animal is dry. It is especially important that the cow be watched during the dry period, as it may be unnoticed until the udder has increased considerably in size; perhaps the secreting structure has been destroyed

and a case of septicemia or blood poisoning has developed as a result of the absorption of the pus from one or more quarters of the udder.

The first changes in a mild case are often overlooked unless the first few streams at each milking are drawn in a wire or gauze covered utensil. This will strain out any clumps of casein or coagulated milk or blood which may be present and would otherwise be overlooked until the condition had become more serious.

The first symptoms in the more acute form of mastitis are chills, staring coat, increased pulse, respiration, and temperature, lameness due to pressure of the hind legs against the inflamed parts, or to pyemic inflammation of the parts or tendon sheaths, edema, swelling, heat and pain in the udder.

The changes in the milk itself vary considerably with the individual cow. The milk may contain only clots of casein or blood, may be thin and watery, of a yellowish color, or show redness due to hemorrhage. This red color when present is quite likely to denote streptococcic infection. Care should be taken to distinguish between the red discoloration, due to infection, and that due to a ruptured blood vessel and the hemorrhage that is so often seen in the heavy milker or the heifer soon after calving. In the latter case the character of the milk should not change, but the fluid is of a pink or slightly reddish tinge, and in some cases contains distinct clots of blood. The salty or metallic taste of the milk is often thought to be due to infection of the udder, but, as a rule, such is not the case. The salty taste is due to an excess of chlorides in the milk. This is usually accompanied by a low acid and low phosphate content. It is often noted in cows before drying off, but becomes more serious when it is present in the cow of high production. The exact cause for this condition has not been determined.

The secretion of milk may decrease considerably or cease entirely, and an exudate of pus be present. This is what happens in the purulent form of mastitis, which is often caused by a dirty milking tube or quill, and also is seen frequently in the dry cow or young calf. In the cow, we frequently have stenosis of the teat and the resulting abscess formation.

These cases of acute inflammation of the udder, with the formation of pus, are quite often accompanied by pneumonia and the development of septicemia. A cow which is being forced for a test or production often has the udder trouble, accompanied by acute indigestion and in some cases by pneumonia as well. Usually the result of this is prostration and death in a few hours, due to the toxemia caused by resorption of the toxic products from these three sources, namely, the lungs, udder, and intestinal tract.

There is another form of mastitis which often runs a very rapid course and in which the death rate is very high, often the animal dying in less than 24 hours after the onset of the disease. When the disease is confined to one quarter, it may be more mild and, instead of absorbing sufficient toxic material to produce death, the quarter sloughs out. This form, known as gangrenous mastitis, results from an infection with organisms of such intense virulence that the blood vessels soon become involved, shutting off the circulation and resulting in the death of any portion or portions of the udder involved.

The color of the organ changes to a dark blue or black. The skin may peel off in patches, and it pits easily on pressure and sometimes shows considerable edema. It is cold and clammy and not painful to manipulate, while the secretion is small in amount and dark, having considerable odor.

The general symptoms are rapid, very weak pulse, with short, jerky breathing and a subnormal temperature. Sometimes the animal is down in extreme prostration and practically unconscious.

The symptoms of tuberculosis of the udder are not definite, and a diagnosis can be made only by finding the bacteria in the milk. The udder becomes hard, firm, and indurated, and usually is not painful unless accompanied by other infections.

Actinomycosis of the udder is not common in this country. The symptoms consist of hard, firm swellings, smaller in size than those present in tuberculosis, with the abscesses more likely to rupture through the skin.

In necrobacillosis of the udder, the symptoms are those of the acute infection. The disease is more likely to appear in a stable where it has been present in the intestinal tract or feet of some animal.

SEQUELAE.

The sequelae or after results of mastitis may be local, confined to the udder, or they may be general, affecting the whole system through absorption of the inflammatory and infectious products present in the disease.

As local sequelae of mastitis, we may have a stenosis, or narrowing, or complete closure of the teat canal or orifice, chronic induration or thickening of the connective tissue framework, with the resulting atrophy of the parenchyma secreting tissue, so that the animal is a light milker in the quarter affected; there may be complete atrophy or abscess formation in the gland, either of which could completely stop secretion.

As general sequelae, we have paralysis, the animal unable to rise; encephalitis and meningitis which would be shown by brain disorders, bronchitis, pneumonia, toxemia, septicemia, and pyemia, with abscess formation in the intestinal organs, or more commonly a pyemic inflammation of the joints and tendon sheaths.

PREVENTION.

One of the first things necessary in the preventing of mastitis is the education of the owner and herdsman as to the cause, method of transmission, and mode of infection of the disease.

At the time of parturition, the cow should be provided with a clean disinfected box stall, or, better still, be allowed to calve out of doors. The hind parts should be washed off with soap and water, or a mild antiseptic, to prevent discharge from running down the udder. Likewise, retained placenta, if not removable, should be cut off near the vulva. Grease and salves as applications to the udder should be avoided when possible, as they tend to collect dirt and filth.

When the cow is in milking stable, she should be confined in a well-bedded stall with a platform of sufficient length, and with some form of partition between her and the next cow, to prevent injury to the udder and teats from the neighbor.

The modified Hoard stall meets this requirement better than any we have seen. It keeps the bedding clean, and when the cow lies down the udder does not come in contact with the floor where the animal has been standing with the hind feet. The gutter should not be too deep, or cows with pendulant udders when standing in the gutter will have the teats in contact with the floor. Then in stepping up out of the gutter, the foot comes in contact with the udder, smearing it with feces.

Clipping the udder lessens the chance of feces becoming lodged there, while washing with soap, water, and antiseptic, as practiced in certified dairies to lessen bacteria count of the milk, may also lessen the cases of mastitis in the herd.

In milking, the first two or three streams of milk are usually discarded, in a certified dairy, to lessen the bacteria count and raise the fat test, as it is this milk which is highest in bacteria and lowest in fat. If this first milk is milked into a pail or other utensil covered by wire or gauze, it will reveal an early or mild form of mastitis that would otherwise be overlooked, or any clots of fibrin, casein, or blood will be caught in the meshes. This also aids in detecting chronic cases which may be spreading the infection slowly to the whole stable. This allows one to begin an early treatment of the cases before the disease has become extensive, and that has an important bearing on the results of the treatment.

The complete stripping of the last milk from the udder is important. In fact, it is worth while to go back after the milking is finished and strip out all the herd.

If there are cases of mastitis in the stable, they should be isolated if possible, or at least put at one end of the milking line or stable. These cases should be milked last and, if possible, by a separate milker.

The milk from a diseased quarter should not be drawn on the floor, but into a pail of antiseptic. This can not be too strongly emphasized, for too often we see these cases milked out onto the floor, spreading the infection to another animal.

When a cow with mastitis is removed from her stall, there should be a thorough disinfection before another animal is placed in that stall. Cowpox, if present in the dairy, should be treated to prevent the exudate from causing an infection of the milk cistern. Likewise wounds and abscesses in the region of the udder should receive special attention to prevent the pus from coming in contact with the teats.

The time the infection is most likely to enter the teat is just after milking when the teat is relaxed. Usually the end of the teat is wet with milk at such a time, and the small drop of milk serves as an excellent medium for the development of bacteria, and the infection finds easy entry into the relaxed teat. Dipping the end of the teats into antiseptic after milking cuts down the chance of infection from this source. It is a short and not expensive process to dip the teats after milking. If a shallow utensil large enough to include all four

teats is used, a great number of animals may be treated in a very short time. The chief danger in dipping the teats is that too strong an antiseptic will be used, which may cause an irritation, thus increasing the danger of infection.

Then, before the cow is allowed to lie down, the bedding under the hind feet should be scraped into the gutter, so that any milk which may have sprayed over the edge of the pail will not remain to increase contamination. If limestone is used in the gutter, the chance of this contamination is further lessened.

The practice of allowing cows which have a more or less abundant discharge from an infected uterus to stand in the milking stable should not be allowed. Likewise, the flushing out of a cow having an infected uterus should not be done in the milking stable.

In preventing infection of the virgin udder, the young heifers should be so confined that they are unable to suck each other's udders, as usually this is the source of the infection. This would mean individual pens or confining the animals for a short time after feeding.

The drying off process is one that should be given careful attention if one wishes to prevent mastitis in the dry animal. A collection of thick milk remaining in the reservoir of the udder is much more likely to encourage the growth of bacteria than is an empty gland.

Rapid increase in protein diet should not be made so as to increase rapidly the congestion of the udder and lower its resistance.

Bacterins play an important part in preventing infection of the udder. If the animal has been given a course of bacterin treatment while dry, or about the time the udder is beginning to develop, the chances of mastitis are lessened. When possible the bacterin should be made from cases of mastitis occurring in the herd.

During the past two years we have made a special study of the use of bacterins in the prevention of mastitis by administering them before calving. The bacterins have been made from cultures from animals in the same herd, and the results have been very satisfactory. The use of bacterins in this way would probably not be justified except in the case of a valuable animal or in a herd where there was considerable trouble from mastitis.

TREATMENT.

• One of the most important factors in the treatment of mastitis is to give the case attention just as early as possible, before it has had time to spread to all parts of the udder.

The diet should be restricted to one low in protein though not to such a degree as to weaken the animal and lower its resistance.

The modern line of treatment calls for a physic, diuretic, hot or cold applications to the udder, massage, frequent milking, suspensory bandage, antiseptics, and bacterins.

In using local applications to the udder, one may use hot or cold, as the results are about equal. There is a little more tendency for abscess formation in the use of hot applications. Personally, we prefer to use cold applications, but we are governed by the weather, using cold in warm weather and warm in cold weather.

Heat may be applied in several ways. Oil or lard combined with turpentine or peppermint, applied hot, holds the heat for some time. Antiphlogistin, or agents of similar character, applied hot, are also good. Hot water is the most common method of applying heat. It may simply be bathed over the part, but a much more satisfactory method is to use a suspensory bandage, packing around the udder with cotton which can be soaked with hot water after the bandage is applied.

The application of cold water is usually more convenient, as it eliminates the labor of heating. In those stables that have a water supply, the hose may be turned on the udder for a long time. The same results may be obtained by using the suspensory bandage with packing; or a piece of rubber sheeting, a rubber lap blanket, or an oilcloth in the form of a suspensory bandage may be filled with cold water to which ice may be added, if desired.

The suspensory bandage is important, not only for the aid it gives in keeping hot or cold applications in contact with the udder, but because it aids in establishing a normal circulation and relieves the congestion of the udder. This is brought about by suspending the weight of the udder from the backbone and pelvis, thereby relieving the tension upon the blood vessels, so that they will assume their normal course and position.

These bandages may be made in a number of different ways. A simple way is to take an ordinary feed sack, soak it in an antiseptic, place it under the udder between the hind legs, and then tie or sew a bandage to the diagonal corners across the pelvis.

Frequent and thorough milking is very important, as it helps to flush out the bacteria from the milk cistern and prevents the absorption of the toxic material. Massage, at the time of milking, brings down into the milk cistern many coagulated masses which have been holding the exudate in the smaller canals of the udder so that it could not be thoroughly milked out.

Antiseptics may be used in three ways: First, by elimination through the milk; second, by injection into the milk cistern; third, by external application.

The use of antiseptics, which are eliminated through the milk and thus disinfect the udder, is new compared to the other methods of treatment. It gives good results in acute cases but is not of great value in old standing cases where the udder has become thickened with new formation of tissue.

Many antiseptics have been used as injections into the milk cistern, but the results are not generally satisfactory, while the process is too slow to treat any number of cases. Acute inflammation of the udder causes a closure of the milk ducts and canals by the swelling and edema which are produced. The exudates that are found likewise help in blocking these ducts so that any solution that is injected into the teat canal does not reach the greater part of the diseased area.

External application of antiseptics is an old method of treating mastitis. It appears to be more particularly useful in treating old cases where the udder has become hard and firm. Most of the agents used are rubefacients as well as antiseptics and produce some results by increasing circulation and leucocytosis. Tincture of iodine, spirits

of camphor, turpentine and oil or lard, and many other agents are used. An ointment which we use frequently is made as follows:

Vaseline.....	pounds.....	2
Spirits of camphor.....	ounces.....	2
Spirits of turpentine.....	do.....	2
Oil of peppermint.....	do.....	$\frac{1}{2}$
Carbolic acid.....	do.....	$\frac{1}{2}$

BACTERINS.

In the treatment, as in the prevention, of mastitis, we believe the bacterins should be made directly from the case, or at least from cases in the same herd, if we are to get the best results.

In the case of abscess formation in the udder, the only treatment is surgical. Where a quarter is filled with pus, the amputation of the teat provides the surest and best drainage. The teat is of no more value, as there will be no further secretion from that quarter, and after it is removed there is a good opening through which the diseased part may be thoroughly washed.

Gangrene, tuberculosis, actinomycosis, and necrobacillosis of the udder call for surgical interference in the removal of half or all of the udder.

Chairman KLEIN. The subject of mastitis has been thoroughly presented in these two papers. The papers on this subject are now open for discussion.

Mr. E. ST. J. BALDWIN. I'd like to ask Doctor Frost if he recommends formaldehyde in the treatment of mastitis given with milk or mineral water.

Doctor FROST. Yes.

Mr. BALDWIN. I have heard of both. You do not recommend either one more than the other?

Doctor FROST. No.

Doctor UDALL. If I understood Doctor Jones correctly, his conclusions were that the infections of the organs have no connection, as far as etiology is concerned, with mastitis. If I understood correctly, I would like to ask whether the bacteriological work served as a basis of conclusion upon an animal suffering from mastitis of frequent occurrence, or whether it was based on bacteriological examination of general organs, or the udder suffering independently?

Chairman KLEIN. I would suggest, Doctor Jones, you take note of these questions and answer them all at the same time. Has anyone else any questions on this subject?

Doctor JONES. In regard to mastitis in general infection, some of the cows were suffering from infectious mastitis. The organism in mastitis was entirely different from that which we commonly found. The general discharges of many cows were examined, and in only two instances do I recall that streptococci would be considered with what we find in mastitis. To my knowledge, in that particular herd, there were not many cases of general infection of mastitis occurring at the same time.

Doctor UDALL. I had in mind especially acute cases.

Doctor JONES. Yes, they were acute cases.

Chairman KLEIN. Has anyone else anything to say on this subject?

The author of the next paper on the program, Professor Stenström, of Sweden, is not present. The secretary has his paper, and if, after we have heard the other papers, you wish to have the secretary read it, we will ask him to do so.

The next paper is entitled "Sterility in dairy cattle." Dr. W. L. Boyd, professor of veterinary medicine, University of Minnesota, is the author, but I do not think he is present.

We have the paper, "The present status of our knowledge of abortion disease," by Dr. C. P. Fitch, chief, division of veterinary medicine, University of Minnesota. I do not see Doctor Fitch.

The next number is a paper by Doctor Per Tuff, professor of anatomy and animal breeding, Agricultural College of Norway. The subject is "Osteomalacia and its occurrence in cattle." Doctor Tuff, as indicated by the program, will not be here.

And next to the last paper is "Bovine tuberculosis control," by Dr. V. A. Moore, director and dean, New York State Veterinary College, Cornell University. I am very glad to say Doctor Moore is present and we will have the pleasure of listening to his paper. Doctor Moore. [Applause.]

Dr. V. A. MOORE. Mr. Chairman, members of the congress: About 25 years ago I was called upon very frequently to discuss the subject of tuberculosis in many of the dairy districts of this State and had occasion to listen to the discussion and the questions from the cattle owners whom we were hoping would extirpate this disease. A little more than a year ago, I had occasion to speak before another body of dairymen on exactly the same subject and to hear their discussions and questions. I must confess that the attitude of mind and apparently the fund of knowledge of these men 25 years ago and a year and a half ago was about the same, and it is the impression that that later discussion had upon me that caused me to prepare the kind of a paper that I have in this connection.

BOVINE TUBERCULOSIS CONTROL.

VERANUS A. MOORE, M. D., V. M. D., dean, New York State Veterinary College, Cornell University, Ithaca, N. Y.

Bovine tuberculosis has interested more people in the United States than any other disease of cattle. This is due to its wide distribution, chronic nature, and its important economic and sanitary significance. Since the discovery of its cause, tuberculosis has been the subject of many and extended researches to ascertain the facts relative to its nature, means for its diagnosis, and methods for its prevention and control. The results of these studies have been published widely, not only in medical, veterinary, and scientific journals, but also in agricultural papers, popular bulletins from State experiment stations, and special reports. It can be assumed, therefore, that any cattle owner who is interested in this disease has been able to familiarize himself with its general and essential features. The question of paramount importance at this time is to devise ways and means for its control.

The evidence is quite conclusive that bovine tuberculosis was brought to the United States by the importation of diseased cattle, long before its infectiousness was recognized generally. It was an

early practice of breeders to sell their cattle, perhaps at auction, when they discovered the existence of this malady among them, without realizing how destructive their method might be to other herds. The chronic course which the disease ran gave rise to the opinion that it was not infectious or communicable.

At first, tuberculosis spread slowly because there was little traffic in dairy animals. Later, when the cities had developed, and a market for large quantities of fresh milk was created, many producers followed the practice of selling dry cows and buying fresh ones, which gave abundant opportunities for infected animals to carry tubercle bacteria into sound herds. Further, the use of separated milk from creameries and whey from cheese factories, accelerated the extension of the disease by infecting many calves. Thus it was that the spread of tubercle bacilli was aided by the practices of the cattle owners themselves until the disease became a veritable scourge.

By the time the cause of tuberculosis was discovered and a means of detecting infected animals was found, bovine tuberculosis had become well established in many of the then milk-producing sections of the country. Several of the newer dairy States created strong livestock sanitary boards, headed by experienced veterinarians, and thereby minimized the distribution of tuberculosis within their borders. In the early days, it was the advanced and obvious cases only that were recognized. When it was found by the use of tuberculin that many apparently healthy cattle were affected, and that not infrequently such animals communicated the specific organisms to sound ones, the detection and elimination of infected individuals became an exceedingly important matter. Its significance was emphasized by the opinion that became prevalent, after the discovery of the tubercle bacillus, that much human tuberculosis was of bovine origin, which for a time gave the disease in cattle much prominence as a factor in public health.

Efforts to eradicate tuberculosis from cattle began officially in this country in 1894. That year the legislature of Massachusetts made a large appropriation for testing dairy cattle with tuberculin, paying the owner for the reactors and destroying them. A similar law was passed in New York in 1895. Other States followed with similar acts. Many herds were tested, and the owners believed they had eliminated the disease. Unfortunately, its subtle nature was not understood, and failure to detect all of the infected individuals on the first test, the buying in of diseased animals, the feeding of infected separated milk from creameries to calves, and laxity in disinfection enabled the disease in many of the herds to reestablish itself in a very few years. The justification for indemnities was based on the opinion that the elimination of tuberculosis from cattle was for the benefit of public health, and consequently the people should share in the financial burden.

If tuberculosis reestablishes itself in herds from which it has been eliminated through the same agencies that it had gained entrance originally, it is obvious that the removal of diseased animals is only an integral part of the problem of permanent eradication. In addition to laws and regulations for detecting and eliminating the infected cattle, there should be an educational awakening to the importance of knowing when and how to bar the reentrance of

the specific organisms. The failure to do this has been the conspicuous weakness of the American methods. The procedure that will be effective should include, as a part of its operation, the education of the owners in those phases of the life history of the disease that it is necessary for them to know in order to safeguard their animals against future infection.

In Europe, conservative measures have been employed for combating this disease. The one known as the Bang method, which has been followed satisfactorily in Denmark, has been the most successful. It consists in removing by slaughter for food, under inspection, the physical cases; in finding, by means of tuberculin, the infected animals in the herd; in keeping the sound and reacting cattle in separate fields and stables; in raising calves from both groups on Pasteurized milk or that from healthy cows. It permits the using, after Pasteurization, of the milk from the reacting and sound animals alike. In from three to five years the tuberculous animals disappear, and they are replaced by healthy ones that have been raised from the herd. This method, while apparently slow in its operation, has the great advantage of being without expense to the State and teaching the owners enough about tuberculosis to enable them to keep their herds free from it after the diseased animals are eliminated. In a recent publication, Bang states: "The eradication of tuberculosis of cattle can, in my opinion, only be accomplished by the cattle breeder himself. That he is able to do it has been proved already about 30 years ago, and it is a great pity that as yet comparatively few have taken up this noble task and fulfilled it." Notwithstanding, the method has not been followed extensively in this country, although it has been employed with pronounced success in a considerable number of herds.

In 1917, the Federal Government introduced what is known as the "accredited-herd plan" for eradicating bovine tuberculosis in cooperation with the States. This method was intended originally for purebred herds only, but it was extended in a short time to all cattle. The plan is the same in principle as that which had been adopted in 1894 in the United States, namely, testing the herds with tuberculin and killing the reacting animals. In order to encourage the breeders, the plan provides certain assistance, such as free tuberculin testing, until the herd is accredited, and the payment of indemnity for reacting cattle, in addition to that awarded by the States when the latter does not equal the appraised value of the animal. Further, it gives official recognition of herds that have become accredited under the plan. This aid furnished by the Government has been accepted generally by the States with considerable variation in the details of its administration. That it has interested cattle breeders and dairymen is assured from the Federal report for August, 1923, which gives a total of 30,838 herds containing 661,260 animals that have already been accredited, and 338,708 herds containing 2,900,003 animals that have passed one negative test. This means that slightly over 1 per cent of our cattle are in herds that are accredited, and 4½ per cent more have passed one negative test.

There is a widespread and growing demand in the United States for the elimination of bovine tuberculosis. This sentiment has been brought about through the education of the owners on the effect of

the disease on their animals which has emphasized its economic importance. They have learned that it is not profitable to maintain diseased cattle. It is difficult to determine the actual loss to the cattle industry of the land caused by this malady. It is known, however, that it is very heavy. In some localities from 10 to 50 per cent of the cattle have been found to be infected, and occasionally all of the individuals in the herd are involved. In addition, the swine kept on the same farms are often affected. The chronic nature of the disease which enables the cattle to be more or less productive while the malady is progressing complicates the measuring of the toll it exacts from the dairymen. The losses in meat production, while not recorded fully, are more definite. In 1920, there were condemned for tuberculosis in the packing houses of the United States that were under Federal inspection, 38,037 whole carcasses and 55,096 parts of carcasses of beef animals, and 65,609 whole carcasses and 535,631 parts of carcasses of swine. It is estimated that about 40 per cent of the cattle and hogs that are killed for food in this country are slaughtered on the farms and in small establishments that do not have Federal inspection. The percentage of tuberculosis in these animals is believed to be much higher than that found in those sold to, and killed by, the large companies. In addition to the direct loss of dairy products, cattle and meat, the people, through the Federal and State appropriations, are spending millions of dollars annually in their efforts to eradicate it.

The extent to which tuberculosis of cattle affects public health has been for many years a subject of controversy. Results of numerous researches have shown that adult human beings are rarely, if ever, affected with the bovine type of tubercle bacteria, but that children are susceptible. Park and Krumwiede found 26 per cent of the fatalities from tuberculosis in children from 5 to 16 years of age and 18 per cent in children under 5 years of age to be due to the bovine type of tubercle bacilli. Krumwiede has reported 101 cases of tuberculous meningitis of which but 6 were caused by tubercle bacilli of the bovine type. In 36 cases of tuberculosis of the cervical glands, he found 30 were due to the human and but 6 to the bovine type. Doctor Park tells me that a recent examination of tuberculous glands from 50 children in New York hospitals showed 42 of them to be due to the human, and 8 to the bovine type of tubercle bacilli. The striking part of this statement was that all of the children infected with the bovine type came from the country. This points to the necessity of obtaining milk from sound cattle for the children in the rural districts where Pasteurization is not practicable, and to the efficiency of Pasteurization in protecting the city consumers. Further evidence that human infection of bovine origin is not extensive is shown by the fact that during the last 10 years tuberculosis in cattle has been spreading, while the number of cases of tuberculosis in man has declined.

In the United States the eradication of bovine tuberculosis has been, and still is, voluntary. Many breeders and dairymen who found they had infected herds have met the situation and, either by the conservative or slaughter method, restored their herds to a tuberculosis-free basis. However, those who have done this are as yet few in comparison with the whole. It appears that the number of owners in

this country who have undertaken the purification of their herds for the purpose of producing milk from sound cattle only and for the benefits to be derived from keeping healthy animals, is not larger proportionately than those who have applied the Bang method in Denmark. A larger part of the eradication work has been accomplished because of the stimulus afforded by the financial aid that has been given by the State and Federal governments. Where indemnities have been high, dairymen have accepted them often without serious thought of their moral obligation to protect their animals against future infection. This is illustrated by the many herds in which the disease became reestablished because the owners were not informed, or indifferent, to the knowledge they should have applied in the care of their cattle.

The frequency of the reappearance of the disease has caused the question to be raised: Why should the State or Federal Government tax the people to pay for infected cattle if their owners ignore the information on the disease available and the instructions for its prevention that have been published widely during the last 30 years for their benefit? It was the hope of the advocates of the accredited-herd plan that the assistance given by the Government would accelerate the efforts of owners to do their part. In a measure, this expectation has been realized, as shown from the large number of applications for tests. Accompanying these requests, there is a feeling on the part of many that cattle breeders who wish a better market for their animals, or their products, because of their freedom from disease, should enter into the campaign of eradication with a more intelligent understanding of the problem and a firmer determination to adhere more closely to the application of preventive principles.

Disease control that has been successful has been governed by the application of definite knowledge of the disease to be controlled. This has been true with human as well as with animal diseases. Yellow fever defied all sanitary measures until it was discovered that its virus was carried from the sick to the well individual by a certain mosquito. When that fact was determined, and its lesson observed, the plague disappeared. Tick or Texas fever in cattle occurred frequently in the northern States, until it was found that its virus was transmitted by a certain tick. The application of this knowledge eliminated the disease. To eradicate bovine tuberculosis, the same strict adherence to its natural history must be observed. When that is done, there is little or no trouble in its elimination; when it is ignored, the outcome by any official method has been disappointing.

It is gratifying to state that there is a steadily growing conviction among cattle owners that tuberculosis must be eliminated. Its complete eradication is the aim of the livestock sanitarians of this country. It involves difficult questions. Tuberculosis appeared among cattle in America about the time improvement in breeding began, so that the development of our best cattle is coincident with its spread. It is in the loss of many of these animals that one finds a serious objection to the slaughter method. If every infected herd could be treated after the Danish plan, the disease would disappear with the animals now living; and the industry would not lose the

products of its best efforts in breeding. To do this, in a practical way, the milk of the reacting animals must be used after Pasteurization, as it is in Denmark. In certain places in California, this is being done with very satisfactory results. Until this practice is adopted generally, it will be difficult, in fact impossible, to apply the conservative method. For most herds it is undoubtedly better economically to follow the American plan. But there are dairymen who have groups of animals, valuable for their fine breeding, and they should understand that it is possible for them to eradicate the disease and at the same time save the breeding that distinguishes their animals. It should be emphasized that the accredited-herd plan permits the owners of such animals to follow the conservative method.

A survey of the results of the methods that have been applied for combating this affection, and the absence of any practical method of immunization against the disease, lead one to believe that the most important thing to hasten its suppression is to educate the breeders of cattle in the true nature of tuberculosis, that they may understand that independently they can, with small expense, free their herds from this scourge. With the generous aid that is being furnished by the State and Federal Governments, the task should not be difficult. Yet there are those who believe that the most that can be expected is to keep it under control. If all cattle owners were of one accord, and their ideas were in harmony with the procedures called for by the nature of the disease, there would be no difficulty in its ultimate elimination. Tuberculosis has been eradicated from many badly infected herds; uninfected herds have been kept free from it; and new herds have been assembled without tuberculosis and maintained as such. I do not know how to emphasize the fundamental principles of disease eradication in any better way than to enumerate the simple rules of action that have guided men who have succeeded in cleaning up their herds and maintaining them in a healthy condition. Their great value rests in the fact that they can be applied independently by the owners or in supplementing any official procedure that may be in operation.

The first, and most important, of these principles is a firm determination on the part of the owners to have herds free from tuberculosis. This carries with it the willingness to do the things required by the nature of the disease to prevent its further spread or introduction. With persons of this kind, the work of eradication is an active process as it must be with all who succeed. Eternal vigilance is the price that must be paid for tuberculosis-free herds.

The second principle is the practical application of the knowledge of the disease in the care of the herd. This is necessary to prevent the spread of the virus to healthy individuals through infected milk, infected buildings, or diseased animals. The voluminous literature on the subject makes it possible for every interested person to acquire this knowledge which is as necessary in maintaining healthy animals as analogous information of how to raise corn and wheat is required to insure a good harvest.

The third factor, and the one that has been the sheet anchor to all, is good technically sound advice. The owner must possess the determination to accomplish the desired results, but his knowledge of

the procedure is usually limited. He is dependent, therefore, on some competent person to guide him. Such a counselor must be near at hand, for the questions that arise are numerous and they must, for good results, be answered wisely and promptly. The people qualified to assist the owners in this work are the veterinarians. They constitute the only group of men who are trained in the particular sciences required to furnish the information necessary. In most cases, where there has been close cooperation between the breeder and his veterinarian, success has been attained. When the work has been taken over by those not disciplined in the life history of the disease, failure has followed in most instances. Further, the local practitioners are informed usually on the conditions existing in the herd which enables them to give more valuable and constructive advice than those who do not have this information.

In the accredited-herd work, the Federal Government recognizes the necessity of the cooperation of the local veterinarians who are to do the subsequent testing and who are to be the advisers of the breeders who continue to maintain healthy herds.

Professor Bang has pointed out very clearly that the eradication of bovine tuberculosis can be accomplished only by the cattle owners themselves. The State and Federal Governments, because of the great importance of this disease, can well afford to assist in its eradication, but there must be cooperation between the owners and their veterinarians for permanent success. Gratuitous aid alone tends to lessen the self-respect of the recipient, and the improvement it may succeed in bringing about is of a passive nature and apt to be temporary. In this country there has been a tendency to rely too much on legislation and regulations and not enough on the application of preventive and sanitary measures by the breeders themselves. The liberal appropriations for indemnities should encourage cattle owners to cooperate fully with the officials who are endeavoring, with ever-increasing success, to aid them in the stupendous task of eliminating the scourge of tuberculosis from the entire country. The crux of the whole matter rests in cattle owners acquiring a workable knowledge of the disease, and a high moral standard that stimulates a genuine pride in the possession of healthy cattle and in producing safe and wholesome products.

Chairman KLEIN. This is a broad subject which has just been discussed by Doctor Moore. As our program has progressed more rapidly than we expected, we have abundant opportunity for discussion. Is there anyone who has anything to say on this question?

We have another paper on the program. "The control of foot-and-mouth disease in Europe," by Dr. Robert von Ostertag, counselor, Württemberg Ministry of the Interior, Germany. I do not see Doctor Ostertag in the audience. According to the program he is not expected to be present, but it was reported to me that he was here.

We passed the paper of O. Stenström, professor of pathological anatomy, Royal Veterinary College, Sweden, entitled "Investigation on the pathology of streptococcic mastitis and on the eventual

transmission of mastitis through milking machines." The paper is here in the hands of the secretary and, if you wish, he will read it. The secretary will present it.

INVESTIGATIONS ON THE PATHOLOGY OF STREPTOCOCCIC MASTITIS AND ON THE TRANSMISSION OF MASTITIS THROUGH MILKING MACHINES.

OLOF EMIL STENSTRÖM, D. M. S., professor of pathological anatomy, Royal Veterinary College, Stockholm.

As milking machines have come into use extensively in Sweden during late years, the following two questions have, among others, arisen for solution:

1. How does milk obtained by means of machines compare as regards bacteriological properties with that obtained by hand?

2. Have the machines any influence on the occurrence and spreading of garget?

The first question I have answered earlier this year in a report to the "Statens Maskin-och Redskapsprofningsanstalt," in which it was shown that milk obtained by the Alfa-Laval and the Omega milking machines showed considerably smaller bacterial contents than milk drawn by hand, provided that the machines were cared for according to the instructions for use. Also, when the hygienic conditions in the cow shed are unfavorable, the difference between the two methods will be chiefly in favor of the machine milking.

As regards the second question, I have undertaken, at Government cost, a long series of investigations, which are soon to be concluded. It may be mentioned, by the way, that there has arisen an opinion, common enough in this country among veterinary surgeons and stock breeders, that, whereas the machines may not directly cause garget, yet they do help to spread it—a view which I, for my own part, indorsed formerly.

In carrying out the investigations mentioned, for the elucidation of this question, I have only worked with the Alfa-Laval milking machine, however, and scrubs and grade cows have been used exclusively in the experiments. I give this piece of information in advance, in case it might be supposed that the breed itself should be credited with any influence as regards susceptibility to this disease, a view which I regard as doubtful, however.

It should further be pointed out that the investigations included streptococcic mastitis only, i. e., the forms of garget which are generally supposed to occur in connection with machine milking, and which begin, stealthily and unnoticed, later to develop into a malignant disease which often leads to a completely agalactic state.

The investigations which were commenced March 23, 1922, were for the most part carried on at the Veterinary College in Stockholm, and the milk samples were bacteriologically examined twice weekly by means of plate cultures on serum agar; in addition, the identical samples were subjected to a general investigation from a hygienic point of view—the amount of deposit on centrifuging, bacteria counts, estimation of hydrogen-ion concentration, etc.—at the Central Agricultural Experiment Station by Prof. Chr. Barthel.

and in addition the State Institution for Veterinary Bacteriology carried out similar control tests up to October 31, 1922.

The first test group included 5 cows just freshened, with healthy udders, and in addition 2 cows with malignant streptococcic mastitis. These latter were milked twice daily with the machines, and afterwards the machines were immediately applied to the healthy cows: this method was used for a period of a fortnight. As no change appeared in the milk or the udders of the healthy cows, I had the two diseased cows hand milked instead, and their milk was mixed with that from other streptococcic cows in early as well as in more advanced stages of garget. In this milk mixture, fresh for each time, the teat cups of the machines were immersed twice daily, immediately before application to the healthy udders, with exactly the same results as before. Not even in the plate cultures from the milk obtained by means of the machines could streptococci be demonstrated.

In order to have an absolutely fresh case of streptococcic mastitis available for the infection experiments, I inoculated a cow just freshened, which had not previously been included in the investigations, with about 300 cubic centimeters of streptococcus milk through the teat duct; the milk came from a couple of fresh cases on a neighboring farm. Although the experiment was repeated three times at certain intervals, only a temporary reaction resulted, except for a slight catarrh remaining in one of the quarters. The other quarters showed no changes when the cow was killed.

Neither could any inflammation of the udder be produced on the 5 test cows by abrasion of the skin of the teats and subsequent application of the infected machines.

The animals on test were killed June 1: the experiments had then lasted during five weeks, with negative results.

The second test group included 3 cows approaching the end of the lactation period, while 3 other cows suffering from streptococcic mastitis were provided as sources of infection. The experiments were carried on as before: the teat cups were filled with streptococcus milk, and immediately applied to the test cows; in addition, scarifications were made inside the teat duct.

Even after eight weeks of this treatment the udders of the cows were still healthy, and streptococci could not be demonstrated in the milk on centrifuging or in plate cultures.

The experiments were then changed in that two of the cows received streptococcus milk per os. After three days, streptococci appeared in the plate cultures: in the centrifuge deposit which was slight throughout, they could not be demonstrated, however. Neither did any symptoms of garget develop which could be demonstrated clinically.

The third test group included 2 cows just freshened, while as sources of infection the milk from two spontaneous cases of streptococcic mastitis was used, in addition to milk from a fresh case induced by injecting a broth culture of streptococci into the udder. The teat cups of the machines were filled with this mixture of milk and applied twice daily to both test cows: at the same time one of these also had streptococcus milk per os.

As regards this cow, I was able to demonstrate streptococci on the plates four days after the commencement of the experiments; on the other hand, the organisms did not appear in the centrifuge sediment until after 11 days, when the amount of sediment had also increased. After three weeks streptococci appeared in all the quarters, which, of course, constituted a clear clinically demonstrated case of garget.

As regards the other cow, which was only exposed to infection through the machines, no streptococci could be found in her milk even after three months. I then had her exposed to a strong draft at a temperature of 3° C. As no visible effect was achieved in this way either, I had her fed with streptococcus milk per os. Although streptococci now appeared sporadically on the serum agar plates, no clinically demonstrable change appeared either in the milk or in the udder; it seemed to me, therefore, that the animal possessed a special power of resistance to infection. That this was actually the case is proved by the fact that in spite of a recent injection of streptococcus milk direct through the teat duct, only a very slight amount of sediment appears in the milk from the infected quarter, and only scanty and isolated colonies are found on the plates. In the udder there are no changes. Still another cow had previously been subjected to direct injection into the udder of streptococcus milk. In spite of an injection of nearly 200 cubic centimeters, a temporary reaction only was produced, lasting for but a few days.

In the meantime, there was an extremely sudden and severe outburst of garget at a farm in Skåne, and of course the epidemic was supposed to be connected with the milking machines. On examination of the herd, I found about 59 per cent of the animals to be infected. Quite a number of cases were due to abscess-producing pyogenes infections; a number were due to streptococcus infection. Regular consignments of milk were sent in twice weekly; the machines were infected by filling the teat cups with this milk and applied twice daily to the cow in question. Even after six weeks no change was noticeable either in the milk or in the udder. This cow was not immune to streptococcus infection, however; I infected her later on by injection of a broth culture of streptococci into the udder.

The fourth series of experiments included 5 cows just freshened, and in addition some recent and some advanced cases of streptococcic mastitis. I now endeavored to determine the factors, known or unknown, which clearly must come into play in order that the virus might occasion the outbreak of the garget.

That individual power of resistance to infection is to be reckoned with is shown by one of the test animals in this series. The cow was first hand milked and fed streptococcus milk per os. After some days, the streptococcus chains appeared on the plates, later to disappear. Machine milking was started, the machines being allowed to work on the udder for 20 minutes after the cow had been milked dry, and with infected teat cups; no change was produced, not even in conjunction with feeding streptococcus milk per os, and hard frozen roots.

I then made an intravenous injection of 100 cubic centimeters of streptococcus culture in ascitis broth; not even a rise in temperature

resulted, and when the cow was killed a week later, no streptococci appeared on the plates from the udder.

Another of the test animals was hand milked and given streptococcus milk per os. A day later, streptococci appeared on the plates. After a week she was fed, among other things, with hard frozen roots, and was also given broth cultures of *Bact. coli*. No garget appeared, and streptococci were to be found only sporadically on the plates. She was then machine milked, with 20 minutes overtime, and still received streptococcus milk per os. After about a week's treatment, long streptococci appeared constantly on the plates, yet there was no increase of sediment in the milk. No garget appeared, not even after scarifications of the teats. All the same, this cow is not resistant to infection, as by the injection of streptococcus milk through the teat duct I have succeeded in producing in her quite a violent attack of garget.

Another cow of this group is not of such great interest, inasmuch as she was found to be infected immediately after freshening with a catarrh of the udder caused by an exceptionally short and slender strain of streptococci.

It may be mentioned, by the way, that I attempted to transfer this strain by means of the machines to other cows, but did not succeed in doing so. I then fed this cow streptococcus milk with long-chained streptococci. Following on this, the amount of sediment increased rapidly, so that from being relatively insignificant, within a few days it came to fill the whole of the cone in an ordinary centrifuge tube.

The giving of this milk was then discontinued, and the amount of sediment went down to 0.1 per cent. A week's exposure to draft produced only an insignificant increase in sediment.

After the animal had been left in peace for some weeks, during which her condition improved, the giving of long streptococci in milk was recommenced. The next day these appeared on the plates, and after three weeks' time the sediment again filled the whole of the cone, always containing long streptococci. When the cow was killed, all the quarters were inflamed, with long-chained streptococci.

The fourth cow in the series is another example of individual resistance to infection. She was hand milked to begin with, and received streptococcus milk per os, with the result that the chains began to appear on the plates after three days, though sporadically.

She was then subjected to machine milking, with 20 minutes overtime and infected teat cups, as well as feeding with streptococcus milk; still the streptococci appeared but sporadically.

A four weeks' period of hand milking and feeding streptococcus milk, together with exposure to strong draft, did not cause garget to break out, although streptococci in long chains appeared constantly. Machine milking was then resumed, but with shorter periods, so that only half of the milk was drawn; the result remained the same.

I then injected 100 cubic centimeters of streptococcus milk in one of the front teats, and an inflammation resulted which was mild in comparison with the last one, however. Still a fortnight after the injection there is no noticeable change in the udder; the

secretion is, however, flocculent. The cow is now being machine milked for extended periods.

Regarding the fifth cow in the series, she was machine milked without overtime, and fed streptococcus milk per os. After some days, the streptococci appeared on the plates and were subsequently found constantly on the plates, although they did not give rise to an outbreak of garget.

As neither feeding with frozen roots or coli cultures broke the cow's power of resistance, I let the machines work 15 minutes overtime. The amount of sediment, which before was up to 0.3 per cent, rose after four days to 0.4 per cent, after another day to 0.6 per cent, and after a few days more to 1.2 per cent. Thus the garget had now appeared.

SUMMARY.

Although the experiments, in which the Alfa-Laval machine only was used, are not yet concluded—among other things the histological examination of the udder preparations still remains—yet they allow some conclusions to be drawn.

1. The experiments show the impossibility of producing garget by the machine milking of healthy udders; not even by the grossest infection of the parts of the machine with the udder secretions of diseased cows, the like of which would never even be approximated in practice, has the infection of the udders of the test cows been effected, either immediately after freshening or during later stages of lactation.

2. To judge from these results, infection by milk plays no part in the occurrence of streptococcic mastitis in practice.

3. The passage of streptococci to the udder from the alimentary canal has constantly been demonstrated.

4. Streptococci may be present in the udder without being demonstrable in the centrifuge sediment, and the cows might thus, as carriers, spread the infection in the cow shed.

5. How far prolonged or shortened milking with the machines may be able to precipitate an outbreak of garget in such carriers can not yet be established, but this point is under consideration.

6. A factor to be reckoned with in investigations such as these is the individual power of resistance of different cows to infection; in some cases this may be so high that large quantities of streptococcus milk can be injected direct through the teat duct without any inflammation resulting.

7. The influence of the breed on the occurrence of the disease—if anything like this exists—is not shown by these experiments but can easily be settled, if occasion arises.

8. I take it for granted that the virulence of the streptococci is of importance, although this is hard to demonstrate, the usual experimental animals being but little sensitive to this virus. Not even after 10 passages through the abdominal cavity of a mouse (introduction and taking out after 30 minutes with a capillary pipette) has any appreciable increase in virulence been demonstrated. Neither has this been possible by cultivation in different media such as ascitis broth, urine, etc.

Chairman KLEIN. Our honorary chairman, Sir Arnold Theiler, desires to say a few words to you at this time.

Honorary Chairman SIR ARNOLD THEILER. Mr. Chairman and gentlemen: Just a few words to thank the brothers of the committee for this distinct mark of courtesy in electing me honorary chairman of this meeting. I can not let this occasion pass without expressing my deep gratitude for the work which American veterinary scientists have done in general and which has so benefited the country in which I live. I have shown you this morning in my paper that the solution of this one problem, that of Texas fever, has thrown light on all investigations throughout the whole field of tropical work. And that is why, thanks to the scientists of America, the Tropics, of which I am a representative, have made so much progress. I wish at the same time to express my gratitude to American veterinarians also for their work which has benefited my own country and which also aided in the World War to such a great extent.

I wish to pay you my highest compliments on the way in which you have done this work, and on the success you have achieved. Furthermore, I wish to say one word in regard to a matter which was introduced at one of the first sessions. In a lecture by Doctor Mohler, Chief of the Bureau of Animal Industry, on "International trade in dairy cattle," he outlined the principles of dealing with infectious diseases in international trade. It has occurred to me now that this may be the beginning of united work along this line. It may be appropriate to point out, at the same time, the necessity of an international meeting of veterinarians. You all know how difficult it is to get our whole family of veterinarians together. I have been informed that a movement is already under way in America to bring the veterinarians from all over the world into a conference. I hope you will carry out this noble suggestion. [Applause.]

Chairman KLEIN. We have here the paper by Doctor Tuff, professor of anatomy and animal breeding, Agricultural College, Norway, and also the paper by Doctor Ostertag. The paper by Doctor Tuff is in English; Doctor Ostertag's is in German. I will ask you to decide whether or not these papers shall be read or whether they shall be filed with the secretary to be published in the proceedings. If anyone here present wishes to hear either of these papers please say so.

Doctor MOORE. I move they be read by title.

(The motion was seconded and carried.)

Chairman KLEIN. The remaining papers on the program for this session will be read by title.

(Adjournment.)

(Papers read by title):

OSTEOMALACIA AND ITS OCCURRENCE IN CATTLE IN NORWAY.

PER TUFF, D. V. S., professor at the Norwegian Agricultural College, Aas, Norway.

The principal necessity for a successful treatment of a disease like osteomalacia is a knowledge of its cause.

In spite of prolonged investigation, the circumstances causing this disease have not yet been fully discovered in all particulars, but it would appear that several different factors are of importance.

The latest theories include the consideration of the disease as an infectious one; others maintain that it is an avitaminosis; whilst others believe that disturbances in the formation of hormone by the internal secretion from certain endocrinous glands play an important part. Intoxications have also been mentioned as possible, either caused by an abnormal fermentation in the digestive organs or by poisonous plants or other poisons which may have got into the food.

These theories and others have to some extent drawn attention from what was formerly generally acknowledged to be the main cause, viz, an insufficient amount of the necessary minerals in the foodstuff. Although the various causes just mentioned may possibly produce the disease in certain circumstances, in practical farming the fact should be reckoned with that the majority of cases are caused mainly by an insufficiency of mineral elements in the foodstuff. To this should be added the results found by the investigation carried on during recent years with regard to the metabolism of mineral elements in the food, viz, that—

(1) The proportion between acid and basic equivalents in the total foodstuffs; and

(2) The proportion between the various metal-ions in the inorganic salts in the food are of the very greatest importance for a normal metabolism of minerals.

The occurrence of osteomalacia in Norway has, in the course of time, yielded a quantity of observations and experiences which may be found to be of interest in this connection.

The disease was formerly very widespread, especially among cattle proper, and was, at any rate in olden times, the disease amongst domestic animals which caused the greatest economic loss to the country.

Although the disease has now lost much of its importance, it may even now appear in some districts, and in certain years, in a very malicious form.

This widespread extent of the disease had two main causes, viz, partly the natural conditions of the country; and partly the very limited and often one-sided feeding which was formerly generally employed. A large number of the cattle live on pastures during the summer. Of the pastures, those on the high mountain plateaus form an essential part.

These investigations of the time, frequency, and place for the occurrence of osteomalacia have been based partly on the official reports from the veterinary surgeons, since 1867, and partly on special investigations of a few districts markedly infected with osteomalacia.

It should be noted, however, that only those animals which have been treated by the veterinary surgeons have been included in the statistics, and they form only a small fraction of the number of real occurrences.

The disease is most pronounced during years with little rain. After a bad year of drought in 1859, a very serious outbreak occurred in 1860. In large districts practically all the stock was attacked and the mortality was heavy. In Upper Telemarken, 200 animals died or were killed. In another district, East Agder, several hundreds of animals were attacked and 25 per cent of them perished.

In another district, Hadeland, the stocks of most farms were touched, 407 animals being treated by the veterinary doctors. In 1863, in the same district, 2,000 cows were attacked, and more than 100 died or had to be slaughtered. The next year the disease appeared on most farms, and on some all the stock perished. In 1868, only 166 cases were treated in the whole country, but the next year the number increased to 2,142, of which 448 died or had to be killed. In 1876-77, there was a very serious outbreak, 3,277 and 3,240 cases, respectively, being treated; in the county of Hedemark alone, 2,132 cases. The next serious outbreaks occurred in 1904-5 and 1911 (2,780 cases) and 1912 (2,741 cases), after the serious droughts of 1904 and 1911. Even in these years the occurrence of the disease was of an epidemic character in many districts, and caused great pecuniary loss by forced slaughtering, deaths, and a general decrease in value both of the livestock and of their produce.

Osteomalacia obtains a wide extent, especially after pronounced droughty years, but there are also typical osteomalacious districts where the disease occurs endemically, independent of the amount of rain, if no special measures are taken against it. As early as in 1863, we have statements that the disease appeared continuously on certain farms in Rennebu, Meldalen, and Orkedalen, near Trondhjem. The very next year it was reported that on one farm in Hadeland the disease had been prevalent for 30 years.

The most pronounced osteomalacious districts, however, are found in southernmost Norway. The conditions in those districts have been investigated by Messrs. Dircks, Werenskjold, Professors Kolderup, Aarstad, and Kjos-Hansen. As these conditions have a general bearing on the question before us, I will discuss them somewhat in detail.

It is reported, as early as in 1862, that the disease appeared every year on certain farms in Aust-Agder. During winter, the cattle were fed chiefly on hay and straw. In 1878, Dircks undertook a chemical analysis of the hay from certain farms where the disease was prevalent. He found the content of ash to be very low, about 2.6 per cent, or only two-fifths of the normal in hay of good quality. The ash of the hay was very rich in silicic acid, but the mutual proportion between lime and phosphoric acid was normal. The percentage of lime and phosphoric acid, on the other hand, was only one-third of the normal, which fact will be seen from the following analysis of three specimens of hay, mown from marshes and outlying pastures:

Lime (CaO)-----per cent--	0.185	0.279	0.287
Phosphoric acid (P ₂ O ₅)-----do----	.155	.143	.129

About 20 years later, Werenskjold analyzed five specimens of similar hay from pronounced osteomalacious districts, and found the content of ash to be very scanty, only 2.90, 3.82, 2.86, 3.75, and 3.45 per cent, respectively; i. e., only half of what is normal in good hay. The content of lime and phosphoric acid was not investigated, but there can hardly be any doubt that the quantities of these minerals were considerably below the normal.

Throughout the winter, therefore, all bones from housekeeping were kept and sometimes bones were even bought from districts where, according to experience, the disease never occurred. These

bones were then given to the cows during the summer. This treatment was a *sine qua non* condition for cattle farming in the most pronounced osteomalacious districts. If the treatment was omitted, the livestock perished.

Amongst other symptoms which frequently accompany the disease in these districts is a pronounced wool-eating in sheep, with rachitic embryos, some of which have deformities (anchylosis and contractions of tendons). Periarticular extoses are also frequent, both in cattle and horses. When the disappearance of the lime salts proceeded slowly, the bones of the tail would grow quite soft and flexible so that the tail could be coiled like a rope. Loose front teeth were also a common symptom. If hay from nonaffected farms was given to the stock, or if the owner of a threatened farm hired summer pasturage on a noninfected farm, his animals were not attacked. Animals moved to pasture on osteomalacious ground acquired the disease.

In the infected districts, a number of interesting observations have been made with regard to the occurrence of the disease.

Formerly, when the winter fodder consisted only of hay and straw with no meal fodder, and when no artificial manure was used for the pastures, the disease appeared at all seasons; but especially in spring when the animals were let loose to graze, a number of fractures of bones occurred. This phenomenon is connected with the fact that the deficiency in minerals in the fodder has been especially great after calving time in the latter part of winter, when the production of milk was comparatively high. After a stronger winter feeding became general, with an addition of meal fodder and the use of artificial manure on the tilled land from which the winter fodder is reaped, the disease changed its appearance. The number of cases during winter and spring was reduced. When, however, the cattle have grazed in the pastures for some time, symptoms of osteomalacia appear, and from the end of June they increase until the cattle are housed for the cold season. One of the first and most pronounced symptoms is a craving for unusual food. The cows will eat wood, earth, and stones, but preferably bones. This unhealthy desire for eating abnormal articles often results in traumatic pericarditis and indigestion. Experience shows that the best means of preventing and curing the disease is to give the cattle crushed bones.

The osteomalacious district which has been most thoroughly investigated is Sokndal, in the southwestern corner of the county of Rogaland. There the disease appears constantly every year and at all seasons, independent of rain or other accidental factors, if no special measures are taken against it. Such districts are often divided off by a sharply defined boundary line from neighboring districts where the disease never appears. Such is the case in the main valley of the Heskestad. On the north side of the valley the disease occurs constantly, and the vegetation there is sparse and inferior, but on the south side of the valley, which has fertile, green, luscious vegetation, the disease is quite unknown. The boundary line follows the bottom of the valley. In other parts of the districts veins of green, fertile soil, with a substratum of diabasic rock run through the osteomalacious district, which is otherwise poor in vegetation. Such is the case with the so-called St. Olav's Road.

which is about $8\frac{1}{2}$ miles long and quite narrow (60 to 150 feet), and which, with its green, fertile vegetation, stands out sharply against the surrounding more or less brown and dry landscape. The disease is never observed there, although it is stationary on both sides.

These experiences point distinctly toward the fact that the composition of the soil is the seat of the cause. The investigations, carried out by Messrs. Kolderup and Aarstad, fully bear this out. Professor Kolderup found that the mountain rocks of the Sokndal-Egersund district, embracing some 1,450 square kilometers, for the main part, viz, 950 square kilometers, consist of Labrador feldspar (anorthosite). This Labrador feldspar forms the rocky substratum of the soil in all pronounced districts of bone-brittleness. Its special characteristic is its slight content of phosphoric acid, only 0.002 per cent. The rocky substratum of the nonaffected districts consists of norite, monzonite, diabase, or similar rocks, with a percentage of phosphoric acid of about 2 per cent. The percentage of lime is comparatively high in both types of rock. The boundary line for the fields of these rocks corresponds exactly to the boundary lines between districts of bone-brittleness and areas where the disease does not occur. In the southern part of Heskestad Valley, the rocks are monzonite. St. Olav's Road is a lead of diabase surrounded by Labrador feldspar (anorthosite).

An analysis of the loose soil and of the hay collected in affected and nonaffected areas shows corresponding variations:

	Osteomalacious areas.		Nonosteomalacious areas.	
	CaO.	P ₂ O ₅ .	CaO.	P ₂ O ₅ .
	Per cent.	Per cent.	Per cent.	Per cent.
Labrador feldspar.....	9.95	0.002		
Norite.....			7.28	1.21
Soil.....	.013	.010	.010	.194
Hay.....	.36	.15	.88	.44

As will be seen from the above analyses, the rocks even in osteomalacious areas contain ample lime, but only a negligible quantity of phosphoric acid. For this reason the loose soil also contains very little P₂O₅, with the further result that the vegetation growing on it is considerably poorer in phosphoric acid and lime than normally.

If the fodder consists solely of hay of the quality described in Aarstad's and Direk's analysis, this will mean a considerable deficiency of mineral salts, more especially of phosphoric acid. Considerable quantities are secreted through the milk alone. In 10 liters (2.28 gallons) of milk there are about 20 grams ($1\frac{1}{2}$ ounces) of phosphoric acid and 17 grams ($1\frac{1}{5}$ ounces) of lime. The remaining loss of mineral matter by metabolism is reckoned as 0.1 gram of lime and 0.05 grams of phosphoric acid per kilogram of body weight. In addition, animals which are growing, or are with young, need considerable quantities of lime and phosphoric acid for the building up of bone tissue. A daily ration of the aforesaid hay of 15 kilograms containing about 50 grams of lime and 22 grains of phosphoric acid, would, to a cow with a daily production of 10 liters of milk, mean a deficiency of lime and especially of phosphoric acid. This defi-

ency increases if the animal is growing or with young. The deficiency is covered, to a great extent, by the mineral matters stored in the skeleton that are dissolved and used. While these stores are diminishing, the lime and phosphoric acid, which are essential parts of other organs, skin, muscles, nervous system, reproductive organs, and blood, are attacked. With the progress of this process of attenuation, the symptoms of the disease appear as a deformity of the skeleton, cramp in the muscles and disturbances of the brain, reduced fertility, anemia, and, at a later stage, complete cachectic condition, and fracture of bones.

THE INFLUENCE OF RAIN.

Experience teaches us that a prolonged drought during the period of growth frequently causes osteomalacia in the following year, especially in areas where the soil is poor in lime and phosphoric acid. Plants become poor in these minerals because the salts are insufficiently dissolved in the dry earth.

In all reports of bad osteomalacia years it is pointed out that there was a serious drought the preceding year. The disease usually ap-

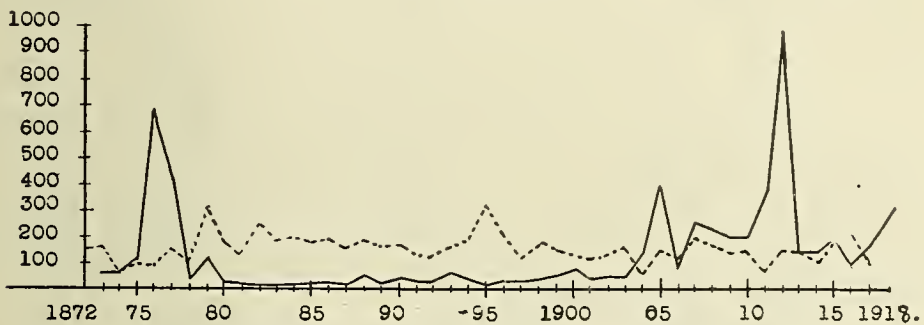


FIG. 1.—Relation of rainfall to incidence of osteomalacia.

pears in February to March, reaches its height in May, and subsides when the cattle are allowed pasture, so that they recover evenly during the summer time. When the animals are let out of doors in spring, there is a general deterioration in their health with pronounced lameness and frequent fractures of bones. If it is a really bad year, the animals do not fully recover until two to three years afterwards.

A comparison between the registered number of cases and the rainfall during the summer in the period of growth for the vegetation, proves that an interdependency of the two factors must exist. In order to make this clear, I have taken the Opland County and computed the average rainfall during the months of May, June, and July for every year from 1872 to 1917.

The curve for the rainfall, constructed on this basis, is given in Figure 1, in conjunction with a curve of the number of registered cases in the county from 1873 to 1918. The number of cases of osteomalacia may here be compared with the rainfall during the preceding year.

From this summary it will be seen that when the summer rainfall becomes essentially less than the average, the result will be a percep-

tible increase in the number of cases of the disease during the next year.

When for various causes any considerable deficiency of mineral substances is established, various symptoms appear which are of the greatest importance in cattle breeding. They are the same symptoms which may be observed in experimental animals which are subjected to a mineral starvation.

The appetite is very much reduced, a general phenomenon in badly attacked stock. Another very characteristic symptom is a perverted appetite, an unconquerable craving to eat abnormal substances like wood, clothes, earth, manure, etc. A veterinarian reports from 1910 that in one cattlehouse the badly attacked cattle had eaten a large portion of the wooden fittings, mangers, and buckets. Another man reports from 1911 that in another cowhouse, the cattle ate practically all the wooden fittings. A third veterinary surgeon relates from a mountain district, in 1912, that the animals which were grazing in the mountain pastures began to eat pieces of slate. Many of them went to the slate quarry every day. Several animals were taken ill, and one cow had to be slaughtered. She had one curve of the intestines stopped with sharp pieces of slate which had cut large wounds in the walls of the intestines, and formed a mass large enough to be felt through the abdominal wall in the living animal.

Indigestion is very common. This may, as demonstrated by Heidenhain, be due partly to insufficient secretion of gastric juice, and partly, as made clear by Hedon and Flaig, to insufficient intestinal peristalsis. In experimental animals both factors could be established through lime starvation, and then cured by adding lime to the fodder. This indigestion is very common amongst cows in osteomalacious areas, and is presumably due to a lack of lime salts in the tissues of the digestive organs.

The stiffness, tenderness, and lameness accompanying the disease are partly due to changes in the skeleton itself, with pressure on the nerves, but they are also due directly to muscular pain caused by the insufficiency of mineral salts. Various nervous symptoms, which in experimental animals may be produced by salt starvation, sometimes appear in the later stages of the disease.

Besides ordinary weakening of all muscles and lameness, there may also occur paralysis, either of the hind part of the body only, or of the fore part only. Total paralysis is less common. Such paralysis appeared formerly quite commonly in cattle attacked by the disease. In sheep and goats also this may be found quite frequently after dry summers, especially in mountain districts. The paralysis generally begins in the hind part, then spreads throughout the body, ending in death if no treatment is undertaken. The disease is cured and prevented by the same treatment as is general in cases of osteomalacia.

In rare cases convulsions and attacks of frenzy occur in connection with the disease. Mr. Furuholmen, veterinary surgeon, in 1905, reports cattle attacked in this way. It corresponds well with what is recorded by Klimmer and Schmidt from an outbreak in 1904 near Dresden. In this case the animals fell prostrate, became paralyzed, and had periodic muscular convulsions, until death came after six to eight hours. The frequent convulsions in the case of swine suffering from rickets have probably the same cause. According to Eulenberg and Zimsson, even in the case of osteomalacia in human beings, tonic and clonic convulsions may occur.

According to the investigations of later years, these nervous symptoms must be due to lack of lime salts in the nervous system. Aron and Sebauer¹ found that dogs fed on food poor in lime had 25 per cent less lime in the brain than the test animals.

Even for a normal continuation of the stock, the existence in the food of sufficient mineral substance is of the greatest importance. Thus it is generally observed in certain districts in Norway that years of osteomalacia are followed by periods of barrenness, a number of the animals, especially the heifers, showing no signs of heat during the later part of winter and in spring. They do not grow sexually normal, and consequently can not breed till after they have been in the pastures for part of the summer. Some stocks which have been very badly attacked have to undergo treatment with preparation of lime and phosphoric acid before the generative organs can once more function normally. During the war, with its dearth of fodder, similar observations were made in Germany. That the functioning of the reproductive organs is dependent on the necessary supply of mineral substances is seen from the experimental investigations by Emmerich and Loew,¹ who, by giving calcium chloride in the food to mice, guinea pigs, and rabbits, demonstrated that these animals not only had more young ones at each litter, but also had more litters per year than the check animals. One experiment showed that mice, fed with calcium chloride, had 33 litters with 202 young, while the check animals bore 27 litters with 133 young. The result of other experiments point in the same direction.

Decrease in the milk yield is a very common consequence of dearth of lime and phosphoric acid in the fodder. In some districts where the disease occurs not only the yield of milk during the milk period is reduced, but the period of barrenness is considerably longer than normal. It often lasts most of the winter. The insufficiency of minerals is probably one of the cooperating causes of this. In Sokndal Valley, the osteomalacious district mentioned above, the milk yield is very low, or ceases altogether, in the affected pastures if the animals are not supplied with minerals. If, on the other hand, they are fed on bone, bone meal, or herring meal, they milk well. On the unaffected pastures the milk yield is good even without such additional fodder. It is commonly supposed by the farmers in these districts that the milk from the affected pastures has a larger content of fat than other milk.

The importance of mineral substances with regard to the milk yield is also evident from American investigations.²

DIE BEKÄMPFUNG DER MAUL- UND KLAUENSEUCHE IN EUROPA.

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Von den ansteckenden Krankheiten des Milchviehs ist unstreitig nächst der Tuberkulose die wichtigste die Maul- und Klauenseuche; denn sie ist durch den Milchgenuss auf den Menschen übertragbar

¹ Landw. Jahrb., v. 48, p. 313.

² Forbes & Beagle. The mineral metabolism of the milk cow. Ohio Agr. Exp. Sta. Bulls. 295 and 308. Meigs and Woodward. The influence of calcium and phosphorus in the feed on the milk yield of dairy cows. Journ. of Dairy Science, vol. iv, 1921, p. 185.

und verursacht der Milchviehhaltung die grössten wirtschaftlichen Schäden. Hinzu kommt, dass dort, wo sich die Maul- und Klauenseuche einmal eingebürgert hat, ihre Bekämpfung wegen der leichten Verschleppbarkeit auch durch sogenannte Zwischenträger ausserordentlich schwer ist, sodass mit ihr als einer dauernden Gefahr zu rechnen ist, die nach vorübergehender Minderung plötzlich wieder stark ansteigt und grosse Verluste herbeizuführen vermag. Die Maul- und Klauenseuche ist in dieser Hinsicht viel gefährlicher als die Rinderpest, die man früher als die gefährlichste aller Rinderseuchen bezeichnet hat. Der letzte Rinderpestausbuch in Europa (Belgien) hat gezeigt, dass man durch die zu ihrer Bekämpfung üblichen strengen Massnahmen (Abschlachtung der verseuchten und gefährdeten Bestände) imstande ist, die Rinderpest in kurzer Zeit völlig zu tilgen. Bei der Rinderpest sterben die erkrankten Tiere, soweit sie nicht aus veterinärpolizeilichen Gründen getötet werden, oder sie genesen und erlangen durch das Ueberstehen der Krankheit eine dauernde Immunität. Hier wird also die staatliche Bekämpfung durch natürliche Vorgänge wesentlich unterstützt.

Bei der Maul- und Klauenseuche verhält es sich bekanntlich ganz anders. Bei der Maul- und Klauenseuche genesen die Tiere bei dem gewöhnlichen gutartigen Verlaufe gewöhnlich nach kurzer Krankheitsdauer, die Immunität der erkrankt gewesenen Tiere gegen eine Neuerkrankung hält aber nur kurze Zeit, längstens ein bis zwei Jahre an. In vielen Fällen erlischt die Immunität bei den von Maul- und Klauenseuche genesenen Rindern schon nach wenigen Monaten, zuweilen selbst nach einigen Wochen, sodass nach dem Erlöschen der Seuche in einem Bezirk bald wieder Tiere vorhanden sind, die für die Neuankömmlinge empfänglich sind. Die Maul- und Klauenseuche ist sehr leicht übertragbar. Von der in den Maul- und Klauenblasen enthaltenen Lymphe genügt nach Löffler und Frosch schon 1/5000 ccm. zur Erzeugung der Krankheit bei einem empfänglichen Tiere, und ausser durch erkrankte Tiere wird die Seuche durch ihre Erzeugnisse, insbesondere Milch, durch ihre mit Blasenlymphe verunreinigten Ausscheidungen (Speichel, Kot) und durch Zwischenträger verschiedenster Art (Personen, Hunde, Geflügel, Vögel, Heu, Stroh, Geräte) verschleppt, die mit kranken Tieren oder ihren Ausscheidungen in Berührung gekommen sind. Der vorletzte Ausbruch der Maul- und Klauenseuche in den Vereinigten Staaten von Nordamerika ist durch Pockenlymphe aus Japan eingeschleppt worden, die nach den Feststellungen von Mohler und Rosenau den Ansteckungsstoff der Maul- und Klauenseuche noch nach einem Jahre enthielt. Sehr wichtig ist ausserdem die Tatsache, dass Tiere, die die Maul- und Klauenseuche überstanden haben, den Ansteckungsstoff noch monatelang auf und in ihrem Körper beherbergen und bei irgend einem Anlass ausscheiden können (Dauerträger des Ansteckungsstoffes), worauf zuerst von Lindquist hingewiesen worden ist.

Durchgeseuchte Tiere können den Ansteckungsstoff der Maul- und Klauenseuche noch einige Zeit lang im Haarkleide der Haut beherbergen, namentlich an den mit Kot beschmutzten Stellen. Vallée und Carré wiesen nach, dass rasch eingetrocknete Blasenlymphe 18 Tage, eingetrocknetes virulentes Blut sogar über drei Monate seine Ansteckungsfähigkeit behält. Ferner wird auf Grund bestimmter Beobachtungen angenommen, dass einzelne durchgeseuchte weibliche

Tiere den Ansteckungsstoff beim nächsten Gebärakt ausscheiden können. Nach Professor Bang ist im nördlichen Schweden, das völlig seuchenfrei gewesen war, die Maul- und Klauenseuche ausgebrochen, nachdem sich bei einem mehrere Monate zuvor dorthin aus Holland eingeführten Zuchtbullen ein Hornspalt erweitert hatte, und der Nürnberger Tierarzt Dr. Böhm hat mit ausgeschnittenem Klauenhorn von Rindern, die vor mehr als acht Monaten die Maul- und Klauenseuche überstanden hatten, gesunde Rinder anstecken können. Diese Infektiosität des Klauenhorns erklärt sich durch die Entwicklung von Blasen oder Aphthen auch auf der Klauenlederhaut und durch die damit zusammenhängende Durchtränkung des neugebildeten Klauenhorns mit ansteckender Blasenlymphe, die frei wird, wenn das Horn herabwächst und durch natürliche Abnützung oder durch das Ausschneiden vom Hornschuh der Klaue entfernt wird (E. Zschokke, J. Böhm).

So ist es zu erklären dass in den meisten europäischen Staaten, wo man die Maul- und Klauenseuche durch mildere Massnahmen zu bekämpfen versucht hat, die Seuche fast jahraus jahrein herrscht und durch die dagegen ergriffenen veterinärpolizeilichen Massnahmen bis jetzt nicht ausgerottet werden konnte. Nur in den Ländern, in denen die ersten Seucheneinschleppungen durch rücksichtslose Tötung der gesamten verseuchten Bestände radikal wie bei der Rinderpest bekämpft wurden, konnte die Maul- und Klauenseuche unterdrückt werden. So gelang es im Laufe der letzten Jahrzehnte, bei den wiederholten Einbrüchen der Maul- und Klauenseuche nach Südschweden und auf die dänischen Inseln, die wahrscheinlich durch Zugvögel vermittelt wurden, ferner bei den Einschleppungen nach England, ebenso wie denjenigen nach den Vereinigten Staaten und nach Australien durch unverzügliche Tötung der verseuchten Bestände die Seuche zu tilgen. Was die Vereinigten Staaten anbelangt, so wurden im Jahre 1902–1903 im Laufe von sieben Monaten in 244 Beständen, 4,712 Rinder, 360 Schweine, und 229 Schafe mit einem Kostenaufwand von \$128,908, im Jahr 1908, 2,025 Rinder, 1,329 Schweine, 275 Schafe und 7 Ziegen mit einem Kostenaufwand von \$90,000 getötet. In noch weiterem Masse wurde die Tötung während des heftigen Seuchenausbruchs in den Jahren 1914 bis 1916 durchgeführt, bei dem nach Melvin, 77,240 Rinder, 85,092 Schweine, 9,767 Schafe und 123 Ziegen getötet wurden mit einem Kostenaufwand von mehr als \$6,000,000. Australien hat sich nach den vorliegenden Nachrichten, nachdem zwei im Jahr 1865, in Viktoria infizierte Bestände durch Tötung beseitigt worden waren, seuchenfrei erhalten.

Die Zahl der von Maul- und Klauenseuchefreien Länder ist gering. Zur Zeit sind seuchenfrei in Europa, England, Schweden und Norwegen: Nordamerika und Australien. Die Seuche herrscht ausser in den meisten Ländern Europas, in Südamerika (Brasilien, Argentinien, Uruguay), ferner in Asien, und auch in Afrika.

Die Gefahr der Maul- und Klauenseuche für die menschliche Gesundheit besteht in der Uebertragbarkeit beim Genusse der Milch und bei der Wartung erkrankter Tiere, die im Gegensatz zu einer Annahme von Lebailly durch hundertfältige Beobachtung, ausserdem durch gelungene Rückübertragung menschlicher Aphthensemite auf das Tier (würtembergisches Landesuntersuchungsamt) bewiesen ist. Durch die neuen, im Anschluss an die letzten starken Seuchen-

gänge in Europa wieder aufgenommenen Forschungen über die Maul- und Klauenseuche ist festgestellt, dass die Milch den Ansteckungsstoff der Maul- und Klauenseuche enthalten kann, ehe sich die spezifischen Blasen entwickeln (Lebailly und Porcher, Ernst und Göbel, u. a.), und dass somit nicht nur die Milch jener Kühe ansteckend ist, die mit Blasen am Euter behaftet sind. Besonders gefährdet sind Kinder, während Erwachsene eine grössere Widerstandsfähigkeit gegen die Erkrankung zeigen und nur verhältnismässig selten erkranken. Während des letzten grossen Seuchenganges in Deutschland sind aber auch schwere Erkrankungen bei Erwachsenen teils nach Milchgenuss, teils nach Infektion durch Umgang mit kranken Tieren beobachtet worden. In einem von Veiel und Krönike beschriebenen Falle (1920) ist eine dreiunddreissig jährige Frau nach Wartung kranken Viehes unter Auftreten von Blasen an der Lippe und Wange schwer erkrankt und nach zehntägiger Krankheitsdauer gestorben. Ausser an der Mundschleimhaut können beim Menschen Blasen an den Fingern und Zehen, an der Lidbindehaut, hinter den Ohren, an der Handfläche sowie an der Sohlenfläche der Füsse auftreten.

Durch Erhitzung auf 85° C. und durch einmaliges Aufkochen wird die Milch unschädlich gemacht. Durch Zentrifugieren wird das Virus der Maul- und Klauenseuche aus der Milch nicht entfernt (Lebailly und Porcher), dagegen wird es durch ausreichende Säuerung in saurer Molke und Buttermilch unschädlich gemacht (Poels und Boersma). Ausnahmsweise wird die Seuche auch durch Genuss von Butter auf den Menschen übertragen.

Die grosse wirtschaftliche Bedeutung der Maul- und Klauenseuche ergibt sich aus dem Rückgang der Milchergiebigkeit während der Erkrankung, der auch nach der Genesung bis zur nächsten Laktationsperiode andauern kann, aus der Abnahme des Körpergewichts, aus der Verringerung des Marktwertes der Milch, weil sie nur in gekochten Zustände verwertet werden darf, aus dem Ausfall an Nachzucht durch Verwerfen und schwierige Wiederaufnahme, ferner durch die hohen Verluste an Kälbern und Ferkeln, die mit der rohen Milch kranker Tiere gefüttert werden und hiernach unter den Erscheinungen einer Herzlähmung schnell sterben können, sowie aus den Verlusten an jungen und alten Klauentieren, insbesondere von Rindern, wenn die Seuche aus unerklärlichen Gründen plötzlich einen bösartigen Verlauf annimmt, wobei die Sterblichkeit 50–70 Prozent betragen kann. Beispiele eines derartigen bösartigen Auftretens bot die Seuche in Württemberg im Jahre 1920–1921, wo von dem etwa ein Million betragenden Rindviehbestand nicht weniger als 45.000—4.5 Prozent—Rinder an der Seuche fielen oder wegen Erkrankung an der Seuche notgeschlachtet werden mussten. Bei der bösartigen Maul- und Klauenseuche sterben die Tiere plötzlich, wie vom Schläge getroffen, an einer Lähmung des Herzens.

Die Maul- und Klauenseuche ist für jedes Land, in dem sie, wenn auch mit mehrjährigen Unterbrechungen, daurend herrscht, eine Geissel, insbesondere für die milchwirtschaftlichen Betriebe. Es verlohnt sich daher der Mühe, die Bekämpfung dieser Seuche auf dem Internationalen Milchwirtschaftlichen Kongress zur Erörterung zu bringen. Die Massnahmen zur Bekämpfung der Maul- und Klauenseuche, die in Europa zur Anwendung gelangen, waren bis jetzt im wesentlichen veterinärpolizeilicher Natur. Hinzu kamen

bei den Seuchenausbrüchen der letzten Jahre die Versuche, durch Behandlung der erkrankten Tiere mit Medikamenten und durch Impfung die Seuche zu bekämpfen.

Die veterinärpolizeilichen Massnahmen stützen sich auf die Erfahrungen über die Verschleppung der Seuche durch die erkrankten Tiere, durch ihre Erzeugnisse, insbesondere durch die Milch, durch ihre Ausscheidungen und durch die mannigfachen Zwischenträger, die mit den Ausscheidungen kranker Tiere in Berührung gekommen sind. Die Zwischenträger, sowohl die belebten als auch die unbelebten, spielen deshalb bei der Verschleppung der Maul- und Klauenseuche eine so grosse Rolle, weil, wie erwähnt, bereits sehr kleine Mengen des Ansteckungsstoffes genügen, um die Krankheit zu übertragen. Veterinärpolizeiliche Massnahmen zur Bekämpfung der Maul- und Klauenseuche sind die sofortige Keulung bei isolierten Neuausbrüchen, im übrigen hauptsächlich die Einsperrung der erkrankten Tiere, die Kochung der Milch, das Verbot des Wegbringens von Dünger, Heu, Stroh, und Geräten aus verseuchten Ställen, das Fernhalten fremder Personen, ferner fremden Klauenviehs von den verseuchten Gehöften, die Verwahrung des Geflügels, sodass es das Gehöft nicht verlassen kann, Festlegung der Hunde, die gleich dem Geflügel als Zwischenträger die Ansteckung vermitteln können.

Andere Massnahmen sind tägliche Desinfektion der Stallgänge der verseuchten Ställe des Gehöfts und ihrer Umgebung und eine gründliche Schlussdesinfektion nach Erlöschen der Seuche, wobei der Desinfektion der Klauen der durchgeseuchten Tiere nach sorgfältigem Ausschneiden, der mit Kot beschmutzten Hautstellen sowie des Düngers durch das von Hecker angegebene, durch Selbsterhitzung wirkende Verfahren der Packung und der Ueberwachung der Desinfektionsarbeiten durch geprüfte Viehseuchendesinfektoren besondere Bedeutung zukommt. Fernere Massnahmen sind, Bildung von Schutzstreifen um die verseuchten Ortschaften, von sogenannten Beobachtungsgebieten, aus denen Klauenvieh nur mit polizeilicher Genehmigung und nach vorheriger amtstierärztlicher Untersuchung ausgeführt werden darf und durch die das Durchtreiben von fremdem Klauenvieh und das Durchfahren mit fremden Wiederkäuergespannen verboten ist. Weiter, Bildung von weiteren, in Deutschland mindestens 15 Km. im Umkreis messenden Gebieten, in denen die Abhaltung von Klauenviehmärkten, abgesehen von Schlachtviehmärkten in Schlachtviehhöfen, der Hausierhandel mit Klauenvieh, die Veranstaltung von Versteigerungen und öffentlichen Tierschauen sowie das Weggeben von nicht ausreichend erhitzter Milch aus den Sammelmolkereien verboten ist und die Abhaltung von Viehmärkten und öffentlichen Tierschauen, soweit sie andere Gattungen als Wiederkäuer und Schweine betreffen, verboten werden kann. Endlich, Forderung von amtstierärztlich bescheinigten Gesundheitszeugnissen für das Handelsvieh während der Dauer der Seuchengefahr.

Diese Massnahmen, die in die wirtschaftlichen Betriebe sehr einschneiden, haben in der Regel eine vollkommene Tilgung der Seuche, d. h. eine Ausrottung, nicht zur Folge gehabt. Sie verhüten nur die weitere Ausbreitung der Seuchenherde und eine Gesamtverseuchung des Landes und haben dadurch ihre volle, wohlberechtigte Bedeutung.

Eine Tilgung der Seuche ist, wie erwähnt, nur durch die Massnahme der Keulung erzielt worden, wenn sich diese nicht bloss auf die

verseuchten Tiere beschränkte, sondern auf die ganzen verseuchten Bestände erstreckte und so frühzeitig vorgenommen wurde, dass eine Verschleppung des Ansteckungsstoffes aus den verseuchten Beständen in andere Bestände noch nicht erfolgen konnte. Auf diese Weise ist die Maul- und Klauenseuche in zahlreichen Fällen auf den Ursprungsherd beschränkt und in einer Reihe von Ländern, die durch natürliche Grenzen vor den mit Maul- und Klauenseuche ständig verseuchten Nachbarländern ausreichend geschützt sind, wiederholt schnell oder nach länger dauernden Bemühungen getilgt worden. Bewunderung flösst die Tilgung der Maul- und Klauenseuche nach ihrer letzten Einschleppung in die Vereinigten Staaten ein, wo die Keulung der verseuchten Bestände noch einen vollen Erfolg gehabt hat, obwohl die Seuche zwei Jahre lang gedauert hatte.

Die unzureichenden Erfolge der veterinärpolizeilichen Bekämpfung nach erfolgloser Anwendung der Tötung bei den ersten Ausbrüchen erklären die vielfältigen Versuche, die Wirksamkeit der veterinärpolizeilichen Massnahmen durch andere Mittel, insbesondere durch die Anwendung von Arzneimitteln und durch Schutzimpfung zu ergänzen.

Es wurden zahlreiche Arzneimittel versucht, um den Verlauf der Maul- und Klauenseuche günstig zu beeinflussen und einen Schutz gegen die Krankheit herbeizuführen. Zur Anwendung kamen, u. a., Sublimat, Kollargol, Eisenpräparate, Arsenpräparate (darunter auch Arsenophenylglyzin, Salvarsan, Neosalvarsan, Chinarsanil, Atoxyl, Natrium Arsenilicum), Brechweinstein, Jodkalium, Chinin, Tryposafrol, Novotryposafrol, Trypoflavin, Trypanblau, Jodincarbon, Euguform, das Benzoessäurepräparat Athanal, und andere Mittel. Zusammenfassend kann gesagt werden, dass man durch bestimmte Medikamente zweifellos den Verlauf der Maul- und Klauenseuche günstig beeinflussen kann. Dagegen ist bis heute kein Arzneimittel irgend welcher Art bekannt, dessen Einverleibung den Tieren einen Schutz gegen die Erkrankung an Maul- und Klauenseuche zu verleihen vermöchte. Die neuerdings von Gins empfohlene Anwendung von Wismutsalzen, wodurch die Empfänglichkeit von Versuchstieren für die Maul- und Klauenseuche ganz erheblich herabgesetzt und auch der Verlauf der Krankheit weitgehend beeinflusst werden könne, ist noch nicht Gegenstand ausreichender Nachprüfung geworden. Ebenso verhält es sich mit der von Rousseau als Heilmittel in Vorschlag gebrachten Mencièrè'schen Guajakol-Benzoesäurelösung (Guajakol 10.0, Acid. benzoic. 2.0, Alkohol 8.0, Aqua dest. 1,000.0).

Auch den Versuchen, die Tiere durch Verabreichung von Bierhefe oder des daraus hergestellten Panphagins (Doyen) zu schützen blieb ebenso wie den Versuchen, durch Kuhpockenlymphe (Ory) Tiere gegen die Erkrankung an Maul- und Klauenseuche fest zu machen, der Erfolg versagt.

Was die Schutzimpfung mit spezifischen Stoffen anbetrifft, so haben Hecker, Löffler, und Frosch nachgewiesen, dass man ein Schutzserum gegen die Maul- und Klauenseuche erlangen kann, wenn Tiere, die die Maul- und Klauenseuche überstanden haben, mit steigenden Mengen von Blasenlymphe intravenös behandelt werden. H. M. Lisbod und A. A. de Rocha haben gezeigt, dass es sich empfiehlt, zum Hochtreiben der Immuntiere nicht nur die Blasenlymphe, sondern in erster Linie das Blasenepithel, das vor der Verimpfung zu ver-

reiben, aufzuschwemmen und grob zu filtrieren ist, zu verwenden, da es grössere Virusmengen enthält als die Blasenlymphe. Durch Einspritzung so gewonnenen Schutzserums kann gefährdeten Rindern eine Immunität von kurzer Dauer von höchstens einigen Wochen verliehen werden. Diese Immunität kann durch wiederholte Einspritzung des Serums verlängert werden. Diese sogenannten passive Immunität reicht aus, um die Ansteckung von Beständen, die sich in der Nachbarschaft verseuchter befinden, zu verhüten, ist aber wegen der kurzen Dauer des Schutzes kein wirksames, allgemein anwendbares Vorbeugungsmittel gegen die Seuche. Die Verwendung des Schutzserums empfiehlt sich neben den veterinärpolizeilichen Massnahmen zur Milderung des Seuchenverlaufs namentlich bei bösartigem Auftreten der Maul- und Klauenseuche und zum Schutze gefährdeter Bestände in der unmittelbaren Umgebung verseuchter, sowie zum Schutze auf Ausstellungen, Märkte, u. s. w., verbrachter Tiere.

Neben dem künstlich, durch Hochtreiben immuner Tiere gewonnen Schutzserum hat sich auch die schon früher von Kitt, König und Tröster sowie später von Del Bono empfohlene Anwendung des Blutserums durchgeseuchter Tiere (Rekonvaleszentenblutserums) als Mittel zur Milderung des Verlaufs der bösartigen Maul- und Klauenseuche gut bewährt, obwohl es einen erheblich geringeren Schutzwert besitzt—in Versuchen von Waldman und Pape einen etwa Zwanzigfach geringeren Wert—als das künstlich gewonnene Schutzserum. Das Rekonvaleszentenblutserum hat bei dem letzten grossen Seuchenzug in Deutschland nach den Vorschlägen von Ernst und Drescher (Schleissheimer Verfahren), Zink und C. Titze, umfangreiche Anwendung in Deutschland, ausserdem in Oesterreich, in der Schweiz und in Frankreich gefunden. Die Wirkung des Rekonvaleszentenblutes ist spezifisch (Waldmann und Pape); die Schutzstoffe erreichen im Blute grosser Tiere bereits am siebten Tage ihre stärkste Konzentration (Waldmann und Trautwein). Wichtig ist die Verwendung von Mischblut verschiedener Tiere (Vallée und Carré), da der Schutzwert des Serums bei den einzelnen durchgeseuchten Tieren verschieden ist. Was den Erfolg der Anwendung des Rekonvaleszentenblutserums anbetrifft, so sind in Bayern von 300,000 geimpften Rindern nur 1.3 Prozent, von 650,000 unbehandelten Tieren dagegen 7 Prozent gefallen (W. Ernst); im Kanton Luzern starben von 8,672 geimpften Rindern 2.2 Prozent, von 3,162 ungeimpften dagegen 23 Prozent (E. Odermatt).

Ein länger dauernder Schutz lässt sich nur dadurch erzielen, dass die Tiere aktiv immunisiert werden, indem sie unter dem Schutze des Schutz- oder Rekonvaleszenten-serums mit Blasenlymphe angesteckt werden. Löffler und Frosch haben festgestellt, dass ein Gemisch von virulenter Lymph mit Blutserum hochimmunisierter Tiere (1/50–1/40 ccm. Lymph + 10–20 ccm. Blutserum) Immunität erzeugt, ohne dass sichtbare Erscheinungen der Krankheit auftreten. Der so hergestellte Impfstoff "Seraphthin" hat sich aber in der Praxis nicht bewährt, da ein grosser Teil der geimpften Tiere entgegen den ursprünglichen Versuchsergebnissen in den Versuchsstallungen an typischer Maul- und Klauenseuche erkrankte, sodass durch den Impfstoff die Seuche verschleppt wurde.

Auch das Verfahren von Leclercq und Nicodème, die als Impfstoff ein Gemisch von 1 Teil Blasenlymphe und 100 Teilen Jod-Jodkalium

verwendeten, scheint unzuverlässig zu sein, ganz abgesehen davon, dass bei dieser Impfmethode von vornherein mit einem bestimmten Prozentsatz von Tieren gerechnet wird, die an typischer Maul- und Klauenseuche erkranken.

Ausser mit Schutzserum und Blasenlymphe wurden Versuche zur aktiven Immunisierung mit Blut und Blutserum angestellt, das nach den Feststellungen des Deutschen Reichsgesundheitsamts, sowie Löfflers und Heckers (1896–1898) während der Zeit des Fieberanstiegs infektiös ist. Die ersten Blutimmunisierungsversuche waren schon von Nosotti (1885) angestellt worden. Nach dem Ergebnis der Untersuchungen der italienischen Forscher Cosco und Aguzzi (1916) ist das Blut maul- und klauenseuchekrankter Rinder während des Fieberstadiums der Krankheit so virulent wie die Blasenlymphe, und der Ansteckungsstoff haftet sowohl an den roten Blutkörperchen als auch am Blutserum.

Nach Cosco und Aguzzi soll die Einspritzung gewaschener roter Blutkörperchen Fieber, aber ohne Blasenbildung und eine zwei Monate anhaltende Immunität erzeugen. Moussu erzielte durch intravenöse Verimpfung von Blut kranker Rinder, das durch Zusatz von Zitratlösung flüssig erhalten worden war Fieber, aber mit Blasenbildung, und einen milden Seuchenverlauf. Aehnliche Versuche waren schon im Jahre 1896, von Kitt und Hermann angestellt worden. Die Tatsache der Blasenbildung ist wichtig, weil Impftiere, bei denen Blasen auftreten, wie natürlich erkrankte Tiere die Seuche zu verschleppen vermögen. Eine Impfung, die zur Blasenbildung führt, ist daher vom seuchenpolizeilichen Standpunkt als bedenklich und nur in verseuchten Beständen, nicht aber ausserhalb solcher, als zulässig anzusehen. Die Angaben Rousseaus, dass man durch Einspritzung defibrinierten Blutes kranker Tiere rasch eine aktive Immunität erzeugen könne, haben sich bei der Nachprüfung in Oesterreich (L. Reisinger) nicht bestätigt. Nach Roux, Vallée Carré und Nocard hat die Einspritzung von etwa 1 ccm. mindestens ein Monat im Eisschrank aufbewahrten Blutserums künstlich infizierter Rinder bei ruhenden Tieren im Stalle die Wirkung, dass sie nur unter Blasenbildung im Maule, nicht dagegen an den Klauen und am Euter erkranken, dabei allerdings auch nur eine Immunität erlangen, die in weniger als sechs Monaten wieder verschwindet.

Alle Arten Impfung, bei denen es zur Blasenbildung kommt, haben aus dem bereits angegebenen Grunde nur die Bedeutung einer Notimpfung, die aus veterinärpolizeilichen Gründen nur in verseuchten Beständen ausgeführt werden darf. Eine wirkliche Schutzimpfung muss, wie auch Hutura und Marek betonen, die geimpften Tiere für eine bestimmte Zeit gegen die Seuche fest machen, ohne bei ihnen Veränderungen herorzurufen, die zur Verschleppung der Seuche führen können. Es muss also eine Schutzimpfung sein ähnlich, wie wir sie bei der Lungenseuche in der Verwendung von Exudatflüssigkeit der erkrankten Brustorgane und in der Reinkultur des Lungenseuchenerregers (in klassischer Form) besitzen, die auf gesunde Tiere verimpft, diese nicht krank, aber nachhaltig Immun machen. Das Seraphthin von Löffler und Frosch das dieser Forderung im Versuchsstall entsprach, hat sie bei der Anwendung in der Praxis nicht erfüllt. Ob das von Vallée und Carré empfohlene Verfahren der subkutanen Verimpfung von Rekonvaleszentenblut (mindestens 1

ecm. auf je Kg. Lebendgewicht) und der sofortigen oder spätestens fünf Tage später nachfolgenden Nachimpfung von 1 bis 10 ecm. virulentem Blute, das eine Immunität ohne offensichtliche Erkrankung erzeugen soll, sich besser bewährt, muss die Nachprüfung lehren. Nach einer weiteren Mitteilung von Roux, Vallée, und Carré, ist mit einer Impfung, die nicht zur Infektion führt, nicht die geringste Immunitätsänderung gegenüber virulentem Materiale verbunden.

Neue Aussichten für die wirksame Bekämpfung der Maul- und Klauenseuche haben sich durch zwei Entdeckungen der jüngsten Zeit eröffnet, nämlich durch die Bestätigung der in Vergessenheit geratenen Entdeckung von Hecker, dass man Meerschweinchen und andere kleine Versuchstiere mit Maul- und Klauenseuche infizieren kann (Waldmann und Pape, Hobmaier) und durch die Entdeckung von C. Titze, dem es durch ein besonderes Verfahren gelungen ist, den Erreger der Maul- und Klauenseuche künstlich zu züchten.

Durch die Feststellung der Uebertragbarkeit der Maul- und Klauenseuche auf Meerschweinchen ist uns ein kleines, leicht in grösseren Mengen zu beschaffendes Versuchstier an die Hand gegeben, von dem man den Ansteekungsstoff in grösserer Menge zu gewinnen, an dem man die komplizierten Immunitätsverhältnisse bei Maul- und Klauenseuche klarzulegen und an dem man die Impfstoffe bequem auszuwerten in der Lage ist. Denn eines der grössten Hindernisse der früheren Maul- und Klauenseucheforschung mit dem Ziele der Gewinnung eines brauchbaren Impfverfahrens war der Umstand gewesen, dass man alle Versuche an grossen Versuchstieren (Rindern, Schweinen und Schafen) vornehmen musste. Denn durch die Beschränkung der Versuchstätigkeit auf diese Tiere gewünschte Einengung wegen der hohen Kosten der Beschaffung der Versuchstiere, wegen der Schwierigkeit der Unterbringung einer grösseren Zahl grosser Versuchstiere in den Versuchsanstalten und wegen der leichteren Verschleppbarkeit der Seuche beim Arbeiten mit grossen Versuchstieren durch das notwendige Wärterpersonal, durch die grossen Mengen des anfallenden Düngers, und die Notwendigkeit der Verwertung von Fleisch und Haut der ausgedienten Versuchstiere. Das Meerschweinchen beseitigt alle diese Schwierigkeiten. Bei Meerschweinchen können Massenversuche angestellt werden, und die Verschleppungsgefahr lässt sich leichter als beim Arbeiten mit grossen Versuchstieren vermeiden wenn die Versuche von einem veterinärpolizeilich denkenden und fühlenden Tierarzt ausgeführt werden, der die erforderlichen Vorsichtsmassregeln gewissermassen automatisch ausführt.

Der Vorsteher des Bakteriologischen Veterinärlaboratoriums im Reichsgesundheitsamt zu Berlin C. Titze hat gezeigt, dass es durch Verwendung eine in bestimmter Art zusammengesetzten Nährbodens möglich ist, den Erreger der Maul- und Klauenseuche künstlich zu züchten. Es ist allerdings vorerst schwierig, die Züchtung in einer ungezählten Zahl von Generationen durchzuführen. Titze gelang dies vorerst nur bis zur vierten Generation, während es dem Professor Pfeiler in Jena, der sich unabhängig von Titze mit der Züchtung des Maul- und Klauenseucheerregers beschäftigt hat, nach seinen Angaben gelungen ist, den Erreger der Maul- und Klauenseuche bis zu mehr als der 200. Generation fort zu züchten. Wenn diese letztere Angabe sich bestätigt—eine Nachprüfung der Pfeilerschen Angabe ist im Gange—besteht noch leichter als nach dem

Verfahren von Titze die Möglichkeit, mit Hilfe des künstlich gezüchteten Ansteckungsstoffes Schutzserum in grossen Mengen herzustellen, und es verbessert sich die Aussicht ähnlich der so erfolgreichen Schutzimpfung gegen den Rotlauf der Schweine, Serum und Kultur so gegeneinander einzustellen, dass man Tiere schützen kann, ohne dass sie erkranken. Vielleicht gelingt es sogar, wie bei der Lungenseuche des Rindes auch bei der Maul- und Klauenseuche durch Impfung mit dem künstlich gezüchteten Ansteckungsstoff, Immunität ohne offensichtliche Erkrankung der Impftiere, insbesondere ohne Blasenbildung, zu erzeugen. Hierfür sprechen Versuche von Titze, die er im Reichsgesundheitsamt zu Berlin ausgeführt hat. Es gelang ihm, durch Einimpfung seiner Kulturen grosse Versuchstiere gegen die Infektion mit virulenter Blasenlymphe zu immunisieren, ohne dass sie an Impf-Maul- und Klauenseuche erkrankten. Die Angelegenheit bedarf aber noch weiterer Erforschung, weil bis jetzt der Weg noch nicht gefunden ist, diesen Erfolg regelmässig zu erzielen.

Wenn die Hoffnungen, die von Titze und von Pfeiler auf ihre Versuche gesetzt werden, in Erfüllung gehen, wird die Bekämpfung der Maul- und Klauenseuche auf eine ganz andere Grundlage gestellt werden, und es wird die Möglichkeit eröffnet, auch in den Ländern, in denen die Maul- und Klauenseuche bis jetzt durch veterinärpolizeiliche Massnahmen nicht ausgerottet werden konnte, die Seuche durch planmässige Durchimpfung der gefährdeten Tierbestände, derjenigen Tiere, die besonderer Ansteckungsgefahr ausgesetzt sind (Handelsvieh, Ausstellungsvieh) sowie des Grenz- und Einfuhrviehes zum Erlösehen zu bringen. Dies wäre nicht bloss für die bis jetzt betroffenen Länder, sondern auch für alle übrigen Länder wegen der vielfältigen Möglichkeiten der Verschleppung der Seuche durch kranke Tiere, tierische Erzeugnisse und Rohstoffe, durch durchgeseuchte Tiere und durch Zwischenträger ein gewaltiger, nicht hoch genug zu veranschlagender Nutzen, nicht zuletzt für die Milchwirtschaft dieser Länder. Durch die künstliche Züchtung des Erregers wird voraussichtlich auch die Schwierigkeit beseitigt werden können, die sich der Schutzimpfung gegen die Maul- und Klauenseuche wegen der Verschiedenheit des Ansteckungsstoffes je nach seiner Herkunft ergeben, wenn sich die Angaben von Vallée und Carré, sowie von Sehein, bestätigen sollten, dass Tiere, die gegen einen heimischen Ansteckungsstoff völlig geschützt sind, gegenüber einem fremden, aus einen anderen Lande stammenden Stamm empfänglich bleiben. Denn durch künstliche Züchtung liessen sich wahrscheinlich polyvalente, gegen eine Mehrzahl von verschiedenen Ansteckungsstoffen wirksame Impfstoffe bereiten. Waldmann (mündliche Mitteilung) hat übrigens bei einer Nachprüfung, bei der er Ansteckungsstoffe aus verschiedenen Ländern prüfte, die Angaben von Vallée und Carré nicht bestätigen können.

Bis alle diese Fragen durch die wissenschaftliche Arbeit, deren letzten Ergebnisse ganz neue Aussichten für die Abwehr und Unterdrückung der Maul- und Klauenseuche eröffnen, ihre Klärung gefunden haben, müssen in den Ländern in denen die Seuche, wenn auch mit Unterbrechungen herrscht, alle bewährten veterinärpolizeilichen Massnahmen und in den Ländern die sich seuchenfrei erhalten oder von einer erfolgten Verseuchung wieder seuchenfrei gemacht haben, die Keulung der von der Seuche betroffenen Bestände als die wirksamsten Mittel bezeichnet werden, um die Seuche zu unterdrücken.

[Abstract.]

CONTROL OF FOOT-AND-MOUTH DISEASE IN EUROPE.

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Among the infectious diseases of dairy cattle the most important one, next to tuberculosis, is undoubtedly foot-and-mouth disease; for it is transferable to man by the use of milk, and causes the greatest economic damage to dairy husbandry. In addition to this the disease is extremely difficult to eradicate wherever it has once taken root, so that it must be considered as a permanent danger.

Through the investigations made in Europe in connection with the last great epidemic (1918-1921), it has been found that the milk may be infected even before the formation of the well-known blisters in the mouth, on the hoofs, or in the udder has taken place. Children are especially exposed to the danger of the disease, although during the last epidemic in Germany there were serious infections of adults also. Milk becomes harmless by heating to 85° C., or by a single boiling, or through the natural acidification which occurs in sour whey and buttermilk (Poels and Boersna). In exceptional cases the infection may be transferred to man by the use of butter.

The economic importance of foot-and-mouth disease results from the reduction of milk production, from the decrease in the uses to which milk may be put, from the loss of meat, from sterility caused by it, from the danger of infection of pigs, and from the heavy losses of adult animals, in the case of the malignant course of the epidemic, in which the mortality amounts to from 50 to 70 per cent.

The difficulties in combating the disease lie in its easy mode of infection, its liability to be spread not only by infected animals, their products and their excretions, but also by intermediate carriers of various kinds (persons, dogs, fowl, birds, hay, straw, stable implements); in the existence of permanent carriers of germs of the infection, and in the absolutely or relatively short period of immunity of inoculated animals.

The most effective measure for control of the disease is immediate slaughter of the infected herds, when recently imported into countries or districts that have not yet been infected. This method has been effective in Sweden, the Danish Islands, England, the United States, and Australia. Even though its enforcement may prove expensive, this measure pays in such countries as are protected by their natural boundaries against constant reintroduction of the epidemic from other lands. Where the infection has taken a firm hold, and one has to reckon with a constant reintroduction from neighboring regions, as happens in most of the European countries, one must, on account of the expense, be content with general veterinary police measures, such as quarantine, restrictions on the transportation of infected and exposed animals, and also of intermediate carriers, and careful disinfection during and after an epidemic. Through the strict enforcement of such measures as these the disease can not be eradicated, it is true, but it may be prevented from spreading further.

For the support of the veterinary police measures, chemotherapy, which has so far been a failure, and protective inoculation, about

the prospects of which no definite judgment can be expressed as yet, were tried in Europe.

Protective serum obtained from highly immunized animals may give endangered herds a so-called passive immunity, which lasts only from one to three weeks, but may favorably influence the especially malignant course of the disease. In the malignant course of the disease the use of serum of inoculated animals (blood serum of convalescents) has proved successful in Germany, in Austria, in Switzerland, and in France. This use had already been recommended by various investigators, but only since the last great epidemic in Germany has it been systematically employed according to the Schleissheimer process. In the blood of inoculated animals the protective substances obtained their strongest concentration as early as the seventh day. A more permanent protection, an active immunity, may be secured through the inoculation of protective serum or convalescent serum and foot-and-mouth disease virus (lymph from blisters or blood of animals suffering from fever). At the present time, however, this active immunization has only the value of an emergency inoculation, practicable only in infected herds, because at least some of the animals subjected to it fall sick with inoculated foot-and-mouth disease, and therefore may, like those naturally infected, spread the epidemic.

Two recent discoveries show, namely, that small experimental animals may be infected with foot-and-mouth disease (Waldemann and Pope), and that cultures of the causative agent may be produced.

The artificial cultivation of the causative agent and the opportunity for mass experiments on guinea pigs improve the prospects for the preparation of a highly effectual, protective serum, and the possibility of producing such a serum and culture that inoculated animals may become immune without falling sick with the formation of blisters. It is also anticipated that a polyvalent vaccine may be prepared which will produce immunity against the various sources of infection.

STERILITY IN DAIRY CATTLE.

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Sterility may be defined as the inability to produce young. It may occur in either the male or female, but its most damaging effects are produced when the female is no longer capable of reproducing her kind. Sterility is one of the chief phenomena or sequelæ of bovine infectious abortion. *Bacterium abortus* Bang is probably not directly responsible for many of the pathologic changes occurring in sterility, yet it frequently paves the way or makes possible the entrance of other microorganisms, which under certain conditions find a suitable field for their growth and multiplication, resulting in either temporary or permanent sterility. Pyogenic bacteria, namely, staphylococci, streptococci, *Bacillus pyogenes* and members of the colon group, are the ones most often met with.

From an economic standpoint, sterility is one of the most important diseases affecting the cattle-raising industry, and with the gradual and steady development of purebred livestock, its importance is

rapidly increasing. The successful development of breeds, characters, and families depends largely upon the mating of individuals possessing normal or healthy reproductive organs. The achievement of this goal is beset with many obstacles, of which the main one is contagious or infectious abortion, as it is widely distributed throughout all countries where cattle breeding is an important industry. The valuable purebred animal's worth is determined mainly by her ability to produce calves of equal or greater value. When the organs of reproduction fail to function properly, her breeding can no longer be depended upon as a source of revenue, and the owner is forced to send her to the shambles for beef prices.

Sterility in the male animal occurs less frequently than in the female, but its importance should not be overlooked. Many herds have suffered a decrease in breeding efficiency as a result of sterility or failure to breed on the part of the sire. Numerous sires affected with impaired breeding efficiency are not always affected with structural changes of the genital organs as a result of infections, but are frequently infertile on account of certain physiologic conditions. Breeders will often continue the use of a proven sire which has reached an advanced age. This practice is in a measure desirable and constructive breeding, but it must be judiciously performed or the owner will suddenly and violently be awakened to the fact that he has a large number of cows with healthy reproductive organs which have failed to conceive or become fertilized as a result of having been mated with a sire whose fertility has become greatly reduced.

Advanced age, overfeeding, obesity, or over condition, as is frequently observed in cattle used for show purposes, together with lack of exercise, are all important factors to be considered in connection with sterility or failure to breed. The sire also may be rendered sterile by injuries of the sheath or penis or testicles, or from specific infections of the various genital organs.

Research work in connection with sterility is being vigorously pursued in this country as well as in Europe. Credit for much of our information on the subject of sterility, both as to its bacteriopathologic and clinical phases, goes to Albrechtsen and Sven Wall, of Denmark, Hess, of Switzerland, and Williams, of the United States. The investigations conducted by the above-named men and by numerous other investigators, have established many interesting facts which have already been of great value to the livestock breeder.

THE RELATION OF DIET TO REPRODUCTION.

The effect of diet on reproduction is a very interesting subject, in which there is very little scientific evidence obtained from experiments in large animals. Almost all of the experimental evidence that has been forthcoming on this subject has been obtained from feeding experiments on rats, guinea pigs, and other small animals. It would seem quite probable that evidence gained in these experiments does not necessarily apply to large animals. However, the work of Hart, McCollum, Steenbock, and Humphrey (2) (3) has definitely proven that a diet restricted to the oat and the wheat plant, even if properly balanced, is not adequate for the nutrition

of breeding cows, and brings about an expulsion from the uterus of a premature calf which is frequently dead, or, if alive, is weak and unthrifty. Forbes (1) in his experimental work with the mineral metabolism of the milk cow, has demonstrated that high-producing cows during their lactation period, are, as a rule, utilizing in their bodies and giving off in their milk more calcium and phosphorus than they are ingesting in their food. Many cows, highly fed for milk and butter production records, have been known to become sterile either temporarily or permanently, while, on the other hand, numerous other cows, just as highly fed and with records equally great, have not suffered with any disorders of their reproductive organs and have continued breeding without any difficulties.

Many of our livestock breeders are now feeding minerals in addition to their regular feeds in the attempt to reduce their losses from contagious abortion and sterility. The lack of vitamins and certain minerals in the diet of cows may bear a very close relationship to certain forms of sterility, but more extensive research will be necessary before these questions can be satisfactorily answered.

RETAINED PLACENTA.

Retention of the fetal membranes, or afterbirth, is one of the prominent symptoms of contagious abortion. These membranes may be retained from other uterine infections, or may occasionally be retained when there is no infection present, such as cases of fatigue from severe and prolonged labor. Retained fetal membranes are very often followed by sterility or failure to again get with calf. As soon as parturition, or the act of calving, has been completed, the fetal membranes have no further function and constitute a mass of dead tissue, which, if not promptly and completely expelled or manually removed, rapidly undergo putrefactive changes. These membranes, when retained, may not only interfere with the future breeding of the cow, but may cause her death as a result of septicemia or blood poisoning.

The arrangement of the placenta in the cow and ewe is more complex than in other domestic animals, and in the cow consists of from 60 to 100 vascular cotyledons (fetal), scattered over the coverings of the fetus and directly attached to the same number of cotyledons (maternal) on the mucous membrane of the uterus of the mother. This is known as a cotyledonary placenta. The nourishment of the fetus takes place by way of the placenta, and the placenta also acts as a filtering system against certain disease-producing elements. If the cow does not expel her fetal membranes within 10 or 12 hours after calving, they are usually indefinitely retained, and must be either manually removed or allowed to remain to be finally expelled after having undergone the process of decay or putrefaction.

The symptoms of retained fetal membranes are not difficult of recognition, the membranes usually, although not always, being protruded through the lips of the vulva. In certain cases, the membranes lie entirely within the uterus; again, a small portion will be found extending through the cervix into the vagina. Within 36 to 48 hours, the membranes will be affected with putrefactive changes, which are characterized by a vaginal discharge of a suppurative

nature containing pieces of placenta, tissue débris, and occasionally portions of maternal cotyledons. The discharge stains the tail, inside of the thighs and udder, and gives off an offensive penetrating odor. Involution of the uterus is delayed, the milk flow as a rule is diminished, there is an elevation of temperature with partial or complete loss of appetite, depending upon the severity of the case. The back may be arched and there may be frequent periods of straining. Constipation is present in most cases, but diarrhea in severe cases is frequently observed. Mammitis is at times found in connection with retention of the fetal membranes. Retention of the fetal membranes is a serious pathologic condition and demands the most careful handling in order to secure the best results. The treatment of cows suffering with retained afterbirth should be attempted only by the veterinarian; and even he finds that if his efforts are to be crowned with success, he must be exceedingly careful and skillful in order to preserve the health and reproductive powers of his patient.

THE CORPUS LUTEUM AND ITS RELATION TO STERILITY.

The corpus luteum is a ductless gland of internal secretion and originates in the ovary following the discharge of a ripe ovum (egg). This spherical-shaped gland is, when fully developed, of a yellowish brown color due to the pigment known as carotin, which according to Palmer and Eckles (4), is identical with the coloring matter of carrots. If the ovum be fertilized, the corpus luteum remains throughout the period of pregnancy and is responsible for maintaining the raised nutrition of the uterus during the manufacturing process of the fetus. If the egg is not fertilized, the corpus luteum normally attains the same size of the corpus luteum of pregnancy, but quite rapidly undergoes degenerative changes, which is followed by the formation of a new corpus luteum at the next estral or heat period. The false corpus luteum, or the corpus luteum which is associated with the unfertilized ovum, does not always undergo the rapid, characteristic, degenerative changes, but remains as large as, and similar to, the corpus luteum of pregnancy. In a great many cows affected in this manner, there is a cessation of estrum, and the cow is thought to be in calf, only to suddenly appear in estrum, much to the disappointment of the owner. The corpus luteum in the cow probably does not undergo as rapid degenerative changes following parturition as it does in other domesticated animals. This may be the explanation of the fact that mares come in heat following parturition much earlier than do cows. In cases (with few exceptions) where the corpus luteum fails to degenerate or become absorbed, it interferes with estrum. This kind of a structure has been termed a persistent corpus luteum. In nonpregnant cows in which there is an absence of estrum, and in which there is a corpus luteum present without other extensive pathologic conditions, the removal of same is, with marked and astonishing regularity, followed by estrum within three to five days. The corpus luteum undoubtedly interferes with ovulation mechanically and by the elaboration of an internal secretion which exerts an inhibitory action on the maturation of the Graafian follicles.

The removal of the corpus luteum in the early stages of gestation is followed by the expulsion of the embryo or fetus within a few days. If a small portion of the lutein tissue remains, regeneration may take place to such an extent that it may prevent abortion. Heifers that have bred too young, or in cases where purebred heifers are in calf to scrub sires, the removal of the corpus luteum will usually result in expulsion of the fetus. This operation can probably best be performed as early as one can be certain the animal in question is pregnant.

PYOMETRITIS.

Pyometra is a condition of the uterus in which there are chronic inflammatory changes of the uterine mucosæ, characterized by sacculation of one or both of the horns, and flaccid muscular walls, with little or no contractile power due to a loss of muscle tone. The uterus is asymmetrical, abdominal in position, and one or both horns are partially filled or distended with pus. The cervix is inflamed and more or less dilated. This pathologic condition most often occurs in cows which have suffered with retention of the fetal membranes, but is known to occur in cases where the membranes were promptly discharged after calving. One of my colleagues, working with the bacterial flora of this condition, has in the large majority of cases been able to isolate *Bacillus pyogenes*, which is apparently the predominating organism in these types of infection.

The history of pyometra is as follows: The owner or herdsman, in describing these cases, states that the affected animal has not been in estrum since calving and that a small pool of pus is as a rule found back of her after she has assumed a recumbent position. They also notice that there is more or less staining of the lips of the vulva, together with collection of pus on the under surface of the tail. In innumerable instances, cows suffering with pyometra are allowed to go for a period of six or seven months before the services of a veterinarian are employed. In the treatment of pyometra, unless begun early, the prognosis should always be guarded, the reason for this being that even though the uterus undergoes complete involution and estrum is regularly established, the regeneration of the mucous membrane is so slow or has been replaced by other tissue so that attachment of the fertilized ovum is made difficult. Or in cases where the ovum does become embedded, early abortions are not infrequent.

The veterinarian who is experienced in the treatment of sterility fully appreciates the value of the dislodgment of the corpus luteum in the successful treatment of pyometra. In cows where the disease has been present only a short time, the corpus luteum will frequently be found projecting above the surface of the ovary, but in the long-standing cases the yellow body will be found to be more centrally located and therefore more difficult in removal. The dislodgment of the corpus luteum in its entirety is usually responsible for such rapid changes in the uterus that one wonders at so much power being invested in so small a structure. Not only does the uterus promptly discharge its contents through the reestablished muscle tone, but it also changes rapidly, morphologically, regaining its symmetry and normal anatomical position within a very short time.

Estrum frequently, though not regularly, appears within three to five days, especially in cases where tissue destruction has not been extensive.

In the treatment of pyometra it is deemed best to siphon off the contents of the uterus before attempting to remove the yellow body. In this way the ovaries can be more readily and safely examined. The uterus can be retracted so that the corpus luteum can be manipulated through the vagina. If the yellow body is deeply situated, it should be removed per vagina, and no doubt this procedure should be followed regularly. We have, however, removed a large number of corpora lutea by pressure exerted through the rectal walls without bad results.

CERVICITIS.

Inflammation of the cervix, or that portion of the reproductive organs which serves as a canal connecting the vagina with the uterus, is a common disorder in the bovine and seriously interferes with reproduction. The cervical canal, which is spiral shaped, varies from 10 to 14 centimeters in length. The walls are very thick and dense. It is exceedingly difficult to dilate. The arrangement of the mucous lining of the cervix is such that once bacteria gain a foothold in the numerous folds and crypts, they become very difficult to dislodge.

Cervicitis may exist as a separate diseased condition, or it may coexist with different pathologic conditions of the uterus, oviducts, and ovaries. Cervicitis yields very stubbornly and slowly to the various treatments that have been recommended, and great care is necessary in the application of same, or the condition, instead of improving, may become more extensive and severe. Some cases will spontaneously recover, and it is recommended that cows suffering with cervicitis be removed from service for a number of heat periods, and nature be allowed to aid in affecting a recovery. It is undoubtedly a very rare instance when the normal cervix of the heifer or cow necessitates manual dilation or opening in order for successful fertilization to occur. This is contrary to the belief of a certain percentage of breeders and caretakers of cattle. There is yet much to be learned about the diseases of the cervix and successful remedies for their prevention and treatment.

DISEASES OF THE OVARIES.

Cystic changes are the most frequently encountered diseases of the ovaries. They are probably most often observed in aborting cows, but are not infrequently met with in cows that have never aborted and whose blood fails to react to the various serological tests. Cystic development of one or both of the ovaries commonly occurs immediately after normal parturition, yet the condition often appears several weeks or months after an abortion, and it also occurs in young unbred heifers. The symptoms produced by cystic ovaries are usually those of nymphomania (chronic buller), and are quite familiar to a large percentage of breeders of cattle.

The origin and etiology of ovarian cysts is not clear. Many of the cysts originate from either a Graafian follicle or a corpus luteum, especially the corpus luteum which has been pathologically retained.

The cow which has suffered with cystic ovaries for several months' duration frequently evidences many changes in her general conformation, the sacro-sciatic ligaments undergo relaxation and the muscles of the rump become shrunk. Changes in the bones of the pelvis permit the "tail head" to become raised high above the lumbar (loin) portion of the spinal column, and creates well-marked depressions at the base of the tail. The neck loses its feminine appearance and becomes coarse and thickened, the voice changes, and in many ways she resembles the male animal.

Cows affected with cystic ovaries as a rule are nonbreeders and unless successfully treated will remain so. Degeneration of the ovaries no doubt takes place quite rapidly, many times becoming so extensive that ovulation is seriously interfered with or entirely suppressed. In those cases wherein treatment is successful, regeneration seems equally as rapid as degeneration; and although the ovary may appear to be entirely destroyed, normal estrum and ovulation will quickly follow complete regeneration. Numerous cows, in which there are cystic changes of the ovary, often suffer fractures in the region of the pelvis, upon being ridden by other cattle or from slipping or falling on cement or hard floors.

Cows affected with cystic ovaries should be treated as early as possible. Long-standing cases do not, as a rule, yield to treatment. Further researches will no doubt enlighten us as to the cause of cystic changes in the ovary, and will be of great aid in enabling the veterinarian to control this now common and serious disease of this portion of the genitalia of the cow. Cystic degeneration of the lining of the uterus is not uncommon, and cystic degeneration has been observed in the mucous lining of the cervical canal.

DISEASES OF THE UTERINE TUBES (OVIDUCTS).

The importance of diseases of the uterine tubes in relation to sterility can not be overestimated. The lumen of these tubes is so small that a slight amount of injury may result in either temporary or permanent sterility. Inflammation is the most common and most important condition affecting the uterine tubes. It may be unilateral, but is frequently bilateral. Hydrosalpinx, which often results from chronic suppurative inflammation of the tubes, is characterized by the accumulation of a clear, straw-colored fluid. The tubes are more or less enlarged, tortuous, and thin walled. If both tubes are thus involved the cow is rendered incurably sterile.

The treatment of diseases of the uterine tubes, in so far as the author is aware, remains undeveloped. Surgical interference in those cases wherein the disease is unilateral is at times apparently productive of good results. Preventive treatment, such as the practice of careful herd hygiene and stable sanitation, with frequent examinations and prompt treatment of any disorders of the cervix, uterus, and ovaries, will aid in the prevention of salpingitis. Diseases of the vagina resulting in sterility are not numerous. The lining of the vagina is smooth, and the epithelial cells are so arranged that unless mechanically injured they do not offer a favorable place for the growth and multiplication of bacteria. Cystic formations of the vagina are not rare, but they seldom interfere with reproduction.

HYPERTROPHY OF THE VAGINAL WALLS.

This is frequently seen, occurring during the late stages of gestation and in the nonpregnant animal. The wall of the vagina, 10 to 12 centimeters anterior to the vulva, laterally and dorsally, becomes hyperplastic so that partial prolapse of the vagina results, ordinarily seen only while the animal is decumbent. Severe inflammatory changes sometimes develop and result in more complete prolapse, induced by straining from the irritation. The condition is ordinarily successfully treated through surgical procedure.

This paper will not permit a discussion of various other diseases of the reproductive organisms. Specific diseases such as tuberculosis, actinomycosis, tumor formations, and congenital defects are important factors, and must be taken into consideration in the investigation of sterility.

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THE PRESENT STATUS OF OUR KNOWLEDGE OF ABORTION DISEASE.

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Abortion has been known to occur among animals from nearly the beginning of history. The last 50 years has seen it recognized as a specific disease and one of economic importance. It has been only during the past 25 years that real progress has been made in determining the etiology, methods of dissemination, and control of this infection, which is of such vital importance to the dairy industry.

Following Bang's discovery of the causative organism in 1897, research workers in different parts of the world have devoted their energies to the study of various phases of the infection. Many important discoveries have been made and several plans proposed for the control of this destructive scourge. The space allotted this paper will not permit details of the different discoveries. It must suffice briefly to review the situation as it appears in the light of our present available knowledge.

Bang, with the assistance of Striboldt, described in detail the cultivation of the germ. The media which they employed and the methods of cultivation were somewhat complex, which further researches have shown to be not necessary. Among those who have contributed to the knowledge of the biology of the germ should be

mentioned M'Fadyean, Nowak, McNeal, Giltner, Huddleson, Evans, and Meyer. We now have available simple methods which render the isolation and cultivation of the germ sure and easy. It is not an anaerobe as the original description led one to believe. It does have peculiar atmospheric requirements, which are satisfied in a number of ways. The most simple is sealing the cotton plug with paraffin or sealing wax. Replacing some of the air with another gas, as carbon dioxide or hydrogen, and reducing the oxygen by partial vacuum or cultures of *B. subtilis* are also commonly employed. These special methods are usually only necessary when isolating the germ directly from the suspected material. After a few generations of transfers on artificial media it grows under ordinary incubator conditions.

One of the things which contributed to the confusion which has existed and still exists in the minds of many in respect to the etiology of abortion among cattle, is the fact that the disease has been designated by one of its symptoms. Another factor which has aided this confusion has been the tendency of investigators and writers to place together all inflammations and other abnormal conditions of the genital tract. In other words, many etiologically unrelated conditions have been associated as having a common cause. The sequelæ of bovine infectious abortion should not be confused with the disease itself. It should be clearly kept in mind that abortion can be caused by several different germs, restricted rations, drugs, mechanical injuries, and yet unknown causes. The germs other than the Bang organism most often associated with abortion, are the vibrio described by the English departmental committee and Theobald Smith, various strains of streptococci, organisms of the colon type, and *B. pyogenes*. The experimental station in Wisconsin has shown that restricted rations may induce abortion in cattle, and Evans, California, and McCollum, John Hopkins, have demonstrated that abortion and sterility in rats can be induced by certain diets. Williams and his associates have found numerous streptococci. Moussu has found paracolon organisms; Holt, Wall, Smith, Traum, and others have found *B. pyogenes*, and the cause of the abortions in the dairy herd at the University of California has not yet been discovered. The committee on abortion of the American Veterinary Medical Association has summarized the situation as follows: "Though cattle abort from various causes, only one kind of infectious abortion among cattle has been found to be both widespread and common." "The essential cause of bovine infectious abortion is *Bact. abortus* Bang. The proportion of abortion due to other causes is relatively small." We believe that nearly all published investigations support this view.

Bact. abortus has not been found in nature, except in the infected animal, or where the germ could be traced to discharges or other contaminations from the infected individual. In the cow it is found in the pregnant uterus, the udder, and their regional lymph nodes. The aborted fetus harbors it in the stomach, intestines, liver, and other organs. It has been found in the genital organs of the bull. It has not been found to exist in the nongravid uterus longer than 65 days following abortion, and usually is absent after three weeks. It may persist indefinitely in the udder, and has been described as

occurring in the udders of virgin heifers. The germ is relatively easily destroyed by disinfectants and natural germicidal agents.

Ever since the discovery by Schroeder and Smith and Fabyan that *Bact. abortus* is commonly present in milk, the relation which this fact has to human health has been carefully studied. It has never been shown that *Bact. abortus* Bang is the cause of any disease of man. It is, however, significant that Alice Evans, Meyer and his associates, and others have shown that there is very little difference between the germ causing Malta fever and the germ of cattle abortion. As further studies of this phase are completed, we may learn that the Bang germ is more closely related to human health than has yet been demonstrated.

The avenues of infection in abortion seem to be the genital and digestive tracts. Bang believed, at the time his original investigations were made, that the principal if not the only way the cow became infected was through the vagina, and that the bull usually was responsible for transmitting the infection. Subsequent investigations have failed to confirm this position. Bovine infectious abortion can be transmitted by feeding material containing the Bang germ. This has been shown in the experiments of Schroeder, Giltner, Moore, Fitch, McFadyean, and many others. Williams's theory of the transmission of the disease to young calves has not been substantiated by the experiments of other investigators. Recently Rettger and White have shown that the disease can be transmitted through the urethral mucosa and by painting the vulva with heavy suspensions of *Bacterium abortus*. These writers were also able to infect one bull out of five by injection of a bacterial suspension into the sheath. We have been able to infect one bull by way of the digestive tract. It would seem that the opinion is justified that infection may come about both through ingesting the germ and by copulation, and that the usual and more common manner is through the digestive tract. We believe, however, that this phase of the disease needs considerable further investigation before the usual mode of infection is thoroughly demonstrated. It has been clearly shown, however, that the most susceptible age is that of sexual maturity, and that infection does take place most often at this time.

The germ is eliminated from the body of the infected female by uterine discharges, fetal membranes, and aborted fetuses. Milk may also contain the germ. Infected bulls may discharge the germs in their seminal fluid and urethral discharges. It is not generally understood that the products of apparently normal parturitions sometimes are teeming with the living virulent organisms. These products include the fetal membranes, uterine fluids, the surface of calves, and their alvine discharges. Abortions occur at any time during pregnancy. It is commonly supposed that they occur more often at the fifth to the seventh month. It is now known that cows abort at 40 to 120 days, and the act often passes unnoticed. An animal may be a carrier and disseminator of the disease and show no symptoms of her condition.

The diseased processes produced by *Bact. abortus* in the cow are largely limited to the chorion and the fetal and maternal cotyledons. The immediate cause of abortion is a disease of the cotyledons. The villi, both maternal and fetal, become necrotic and finally soften by

autolysis, and fatty degeneration releases both. The diseased cotyledons are sometimes withheld, and retained placenta results. A purulent inflammation caused by bacteria other than the abortion germ may be established, leading to endometritis, pyometra, and inflammations of other parts of the female generative system. The chorionic epithelium, in particular, is invaded by the abortion germ. These cells are more or less altered in size, and the nucleus may become pyknotic. Other types of epithelia, as those of the amnion and uterine mucosa, have not been found invaded. The changes produced in the udder are usually not visible macroscopically, and often microscopic examination fails to show significant alterations. In some cases of udder invasion the acini are filled loosely with polymorphonuclear leucocytes, and Smith reports some acidophils. There are also some collections of lymphoid cells, especially in the interstitial tissue. The udders of three animals recently killed at University Farm, which have harbored the abortion germ for some years in their udders, showed small areas filled with a yellowish thick fluid. This material, on microscopic examination, proved to be made up largely of polymorphonuclear leucocytes and fibrin. *Bact. abortus* was isolated from these foci.

The lesions produced in male animals are usually abscesses located in the seminal vesicles, testicles or epididymi. The germ can not be isolated from many bulls which show evidence of infection by the blood tests.

The small experimental animals, rabbits, guinea pigs, and mice, are quite susceptible to infection by the Bang germ. In guinea pigs particularly, a rather specific disease is produced which has been carefully described by Schroeder and Cotton, Smith and Fabyan.

The diagnosis of bovine infectious abortion is not difficult, as a rule. The blood tests, agglutination and complement fixation, are reliable if properly carried out and rightly interpreted. The breeding history of the herd is an important factor when finally determining the proper control procedure. Bacteriological studies of aborted fetuses, placenta, and uterine and vaginal discharges, as well as the organs and fluids from bulls, often give very valuable information. It shows poor judgment to state that the disease is present in a herd or individual until a blood test or bacteriological examination is made. As stated in the beginning of this paper, abortions are not all due to the same cause, and one is not justified in stating that the disease due to the Bang germ is present until methods of precision have shown that such is the case. It should be clearly set forth that a positive reaction to the blood test for the presence of the Bang germ does not signify that the animal from which the blood was drawn has ever aborted or ever will abort. It is evidence, except in suckling calves, that the animal has been or is infected with *Bact. abortus* Bang. Likewise, a negative test is not a positive guaranty that the animal will carry her calf full term. She may be in the incubative stage and her blood not contain the antibodies.

This disease has frequent complications, which include inflammation of various parts of the reproductive organs, cystic ovaries, and retained corpora lutea. These induce a temporary or permanent sterility which bring about losses equal if not greater than the act of abortion itself. The common cause of these various inflammations

is usually bacteria belonging to the pyogenic group, including staphylococci, streptococci, colon bacilli and *Bacillus pyogenes*. It does happen, however, that some cases of nonbreeding can not be explained by infection. In these cases oftentimes the physiological functioning of the ovaries is at fault. There are many cases of inflammation of the genital tract which are not primarily caused by *Bact. abortus*. It happens that the pyogenic bacteria can multiply without having the soil prepared by the abortion germ. Sterility, therefore, is not inseparably connected with abortion, and its etiology is usually distinct.

The prevention and control of bovine infectious abortion are the phases of the disease which concern most intimately the dairy industry. Before an infectious disease can be successfully controlled it is necessary that knowledge of the infection be common property. Ignorance of the biological laws governing the cause and methods of spread leads to a great and unnecessary loss. Knowledge is the basis of control, and this knowledge must be widely disseminated. Before successful methods for the control of bovine infectious abortion can be applied, cattle owners must appreciate the seriousness of the disease, and be aware of the methods by which the disease gains entrance to their herds, or if it is already present, how it spreads. Sanitary control can not be efficient without the whole-hearted and vigorous support of the owners of cattle. This can be brought about only by a campaign of education, which will impress on the cattle-owning public the salient facts concerning the infection. This is well illustrated by the present campaign for the control and ultimate eradication of bovine tuberculosis in the United States. Twenty years ago, the present methods could not have been applied because the public, and I speak in particular of the cattle-owning public, was not aware of the seriousness of tuberculosis and how the disease spreads and how it can be controlled. It has taken a great effort to bring this change of front about, but it has been done, and it can be done again in respect to abortion. This congress could do a great deal in initiating work leading to the education of its patrons and others interested in the dairy cow. All educational institutions should be solicited for aid, and in a few years much would be accomplished.

A feature, which in my judgment has hindered the control of abortion, is the continual seeking for an "easy way" to eliminate the infection from a herd. Some medicinal or biological agent, fed to or injected into an animal, which will cure or immunize has been the goal of our ambitions. Something has been accomplished in this field, but it can be safely said that as yet there is no entirely successful prophylactic or therapeutic treatment. We must use, to the fullest extent, the tools which have already been placed in our hands, and no longer wait for the vaccine or drug which can be used as a specific.

Three classes of herds, in respect to this disease, present themselves for consideration: (1) The uninfected or clean herd; (2) the slightly infected herd; (3) the badly infected herd. These classes can be differentiated only by means of the blood tests and the herd history. The separation into one or the other of these groups is the first step in control. The later procedures are dependent on the results obtained by the tests and history.

If it is determined that a given herd belongs in group 1, or is free of the infection, every precaution should be taken to keep this most serious disease out of the herd. As great, if not greater, care should be taken concerning abortion as is given to keep the herd free of tuberculosis. No new animals should be brought into the herd until they have had their blood tested, and have been determined free of the disease. Before the recent purchases are allowed to mingle with the herd, they should be kept in quarantine and have a second blood test made after 60 days. Care should be taken to keep stray animals out of the pastures. Bulls should not be used for outside service. Pregnant heifers in particular should be most carefully watched to guard against infection.

The herds included in group 2 are those showing, by test and history, less than 10 per cent of infection. Two procedures seem to be indicated. If the infected individuals are not valuable, they should be disposed of for immediate slaughter. If they are valuable animals and the conditions on the farm are favorable, these individuals should be isolated from the rest of the herd. The stable should be thoroughly cleaned and disinfected. All females should be isolated at the time of parturition, and kept away from the herd until all discharges cease. An infected herd kept at a place separate and distinct from the clean herd may be practicable under certain circumstances. Calves born from the infected group can be grown up in clean surroundings, tested, and if not affected placed in the clean herd. The details of procedure must be varied to fit the local conditions, and a uniform method can not be recommended. That this method will succeed has been demonstrated by the Oregon station, by M'Fadyean in England, and by Robinson in South Africa. However, it presents many difficulties which can be overcome only by constant care for the details which are so often overlooked.

In a badly infected herd, group 3, three procedures are available. If the animals are grades and not valuable as dairy animals, the whole herd may be sold for immediate slaughter. A clean herd can be purchased only when the same care is taken, as to test, quarantine, retest, and herd history, which has now become rather common practice in respect to tuberculosis. It is folly to dispose of one herd at a loss and replace it with one equally as badly infected. There is no question also that a herd immunity is gradually built up if new animals are not placed with those already infected. This is well demonstrated by the dairy herds in the vicinity of San Francisco and reported by Hart.

Another procedure which may be attempted is to build up a clean herd by removing the calves at from 3 to 4 months of age and rearing them separately from the infected herd. Constant and repeated blood tests are necessary to weed out any calf, heifer, or bull which may become infected. This method is particularly applicable when two farms are available which are distinct and separate.

Finally, living abortion vaccines may be employed. Much has been written concerning the value of these agents in the control of bovine infectious abortion. They have been widely used in England, especially as reported in the so-called Bland experiments. Zwick and Zeller, Schermer and Ehrlich in Germany, and Hadley and Schroeder in the United States report good results from their use. The ex-

periments conducted at University Farm, St. Paul, and those published indicate that the living vaccine will reduce the abortion rate, but that by so doing the infection is constantly kept alive. Furthermore, there will always be some abortions in a herd so treated. The results reported by investigators indicate that dead organisms are of little value in producing immunity.

Our experiments have shown that there is great individual variation in animals in respect to immunization. Hagan found this true also in guinea pigs. Zeller reports some recent experiments which indicate that an active disease is not established in the body of an animal injected subcutaneously with the living germs. This is a very important factor. Schroeder has shown that 79 per cent of the commercial vaccines which he obtained in the United States were valueless from various causes. Taking into consideration all available data, we agree with the statement of Hart: "While under certain conditions, the use of live abortion germ vaccine can be recommended after due consideration of all factors involved, this course of procedure should not be adopted by owners without full knowledge of the facts and possible consequences." We further agree with Simms and Miller, who state: "No economical method of eradicating abortion from badly infected herds of common cattle has been found. Perhaps vaccination may increase the resistance of these animals to some extent, but as stated elsewhere, the vaccines are still in the experimental stage."

In conclusion, police measures should be gradually invoked to prevent the traffic in recent aborters. The most fertile source of the spread of bovine infectious abortion is the animal which has recently aborted, and her sale should be prevented by law.

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 C. C. Browning.
 S. J. Crumbine.
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 Oscar Dowling.

REGULATIONS.

ARTICLE I. Official delegates shall be those specifically designated representatives of national, State, municipal or provincial governments, and of educational or research institutions supported by governments.

Association delegates shall be those specifically designated by associations as their authorized representatives.

Member delegates shall be all those not specifically designated as representing a government, institution, or association.

All delegates shall have equal standing at all sessions of the congress.

ART. II. All matters relating to the program, including the reading of papers in absentia, shall be decided by the chairman of the program committee.

ART. III. Speakers in the discussion shall be limited to five minutes, and may not speak more than twice on the same subject except at the discretion of the presiding officer.

ART. IV. English shall be the official language of the congress, but papers may also be presented and discussed in French, German, or Spanish. A synopsis of each discussion will be presented in the other three languages. To insure accuracy, each speaker should, if possible, submit in writing in one of the four languages specified, a copy of his remarks or proposals.

ART. V. Proceedings shall be published by the United States Department of Agriculture.

ART. VI. In all matters not otherwise provided for, the decision of the executive committee of the World's Dairy Congress Association, Inc., shall be final.

ART. VII. The congress shall not have authority to obligate the governments or organizations represented, though it may make such suggestions and recommendations as it may deem to be in the interest of the dairy science and industry.

PURPOSE AND PLAN OF THE CONGRESS.

The post-war period found the dairy industry of the world confronted with new problems, the international exchange of scientific knowledge interrupted. The time seemed ripe for a meeting of leaders in research, education, and business.

The United States took the initiative. Dairy scientists and industrial leaders formed a temporary organization in October, 1920, which became permanent a year later, with the name of World's Dairy Congress Association, Inc. The cooperation of the United States Government was assured through the Department of Agriculture and other departments, and the World's Dairy Congress was authorized by act of Congress of the United States of America, effective March 3, 1921. Invitations to the nations of the world to send delegates were issued by the President of the United States of America through its diplomatic representatives.

The World's Dairy Congress was the first international dairy conference to be held in the United States. It has had the cooperation of the International Dairy Federation, which has its headquarters at Brussels, Belgium, and of the many national and local dairy organizations of the United States.

The purpose of the World's Dairy Congress was to effect an international exchange of the latest knowledge of the sciences and practices of dairying, and of the methods and results of a rational use of milk and its products in the human diet.

Its object was to bring together the leaders who are directing the trend of the dairy industry; to study the economic forces which influence domestic and international commerce in dairy animals, products and equipment; to discuss methods of disease prevention and of regulating and controlling the sanitation and standardization of dairy products; to consider the influence of a wise use of milk and its products on national health, and the vital importance of the part which they play in human physical and mental development.

The plan of the congress was to effect an oral presentation and discussion of that progress which is in advance of the printed page; to assemble the results of research and of industrial practice relating to the milk cow and her products, and their relation to human welfare so that they may serve four

great groups of people: (1) Investigators and teachers; (2) producers, manufacturers, and distributors; (3) regulatory and control officials; (4) health and welfare workers.

The program was arranged in sections to bring together papers on similar or related subjects.

EXCURSIONS AND OTHER ACTIVITIES.

Excursions were arranged with the cooperation of local committees to points of scenic, historic, and technical interest.

Excursion No. 1, to the Pacific coast, under the leadership of J. E. Dorman, of the Dairy Division of the United States Department of Agriculture, included Chicago, University of Wisconsin, University of Minnesota, Yellowstone National Park, Grand Canyon of Colorado, many Pacific coast cities, and intermediate points of interest.

Excursion No. 2, to the Central West, under the leadership of M. H. Fohrman of the Dairy Division of the United States Department of Agriculture, included Chicago and different parts of Wisconsin, Minnesota, and Iowa.

Excursion No. 3, led by J. B. Parker, of the Dairy Division of the United States Department of Agriculture, included the Eastern States Exposition, Boston, Niagara Falls, Pennsylvania State College, and Grove City, Pa.

Excursion No. 4 was conducted by Charles A. Taylor, of Cornell University, and included the New York State Agricultural Experiment Station, Cornell University, and various intermediate points of interest.

Excursion No. 5 was also conducted by Charles A. Taylor, of Cornell University, and included points of interest to those attending the congress, north and east of Syracuse and the cheese district of New York State.

Excursion No. 6 was the New York City excursion, conducted by I. Elkin Nathans, of the New York Milk Conference Board, to points of interest in and about New York City.

Short excursions were arranged by the hospitality committees of Washington, Philadelphia, and Syracuse.

Monday evening, October 1, preceding the opening of the World's Dairy Congress in Washington, D. C., the delegates and visitors were entertained at the Willard Hotel by a series of moving-picture films, presented by the United States Department of Agriculture and the United States Department of the Interior.

A committee representing the dairy interests of Washington and vicinity, I. C. Weld, chairman, tendered a banquet to all delegates. Tuesday, October 2, the first evening of the congress. In recognition of the international character of the gathering, Dr. C. W. Larson, chief of the Dairy Division of the United States Department of Agriculture, called a roll of the nations represented. As the name of each nation was called, the delegates from that country arose and stood while their flag was unfurled and the orchestra played their national song.

The Philadelphia committee, of which Mr. Henry N. Woolman was chairman, provided breakfast for the delegates on their arrival in Philadelphia, Wednesday morning, October 3. In the evening a banquet was held, with several short plays, illustrating the methods of the dairy council, shown between courses, and followed by addresses by a number of distinguished speakers.

At the close of the sessions of the congress in Syracuse, Monday morning, October 8, 1923, Syracuse University entertained the delegates at a luncheon. Following the luncheon, at a special convocation of the university, honorary degrees were conferred upon members of the congress, by the chancellor of the university. Doctor Flint, the chancellor, said:

Robert Burri, doctor of philosophy of the University of Zurich, director of the Swiss Agricultural and Bacteriological Institute, you are the honored representative of our sturdy sister Republic, with its fruitful valleys and the light of freedom on its mountains. Because we appreciate your scholarship and research, and your notable contributions to the development of dairy bacteriology, I gladly admit you to the degree of doctor of science, *causa honoris*, and invest you with all the rights and privileges appertaining to that degree.

From our nearest international neighbor, the land of the maple leaf, we greet you, Charles John Colwell Orr Hastings, doctor of medicine, doctor of laws, as a pioneer and leader in the cause of public health. In recognition, both of your scientific knowledge and professional skill, and of the dedication of these to the service of humanity, for your signally successful service to the Queen City of old Upper Canada in life saving and life extending, as medical health officer of Toronto, I admit you to the degree of doctor of science, *causa honoris*, and invest you with all the rights and privileges appertaining to that degree. May I add that my pleasure in this act is not lessened by discovering but yesterday that you and I were born in the same county, in the same township, practically in the same village, and attended the same high school, though I must confess we may not recall one another among our boyhood playmates.

You come to us from the rugged northland, piercing the Arctic Circle, Haakon Isaachsen, Commander Danish Dannebrog, as the official representative of the Government of Norway, and a personal representative of that hardy race, from which America has received such a generous infusion of sturdiness and energy. In appreciation of your significant service as professor of animal nutrition in the Royal Agricultural College of Norway, of the value of your experimentation and of your contribution to the literature of scientific agriculture; and in honor of your respected nation and of the whole Scandinavian peninsula, I gladly admit you to the degree of doctor of science, *causa honoris*, and invest you with all the rights and privileges appertaining to that degree.

Honored representative of a people gloriously adventurous throughout centuries of history, and ever highly esteemed for courage and character. Sigurd Orla-Jensen, doctor of philosophy of the University of Copenhagen, professor of technical biochemistry in the Royal Agricultural and Veterinary College of Denmark, Knight of Dannebrog, for your scholarship and research, known and respected across many national boundaries, for able editorship and for authorship of many scientific and technical treatises and volumes, one of which is in daily use as a textbook in Syracuse University, I gladly admit you to the degree of doctor of science, *causa honoris*, and invest you with all the rights and privileges appertaining to that degree.

The land of the thistle and the heather, the land of liberty and enlightenment, the land of staunch religious faith and high attainments in world scholarship, grand old Scotland, to-day presents to us, you, Gerald Leighton, doctor of

medicine and Fellow of the Royal Society of Edinburgh. For the worthiness with which you represent your country, for your high reputation as zoologist and pathologist, for your valuable publications, both scientific and cultural, I gladly admit you to the degree of doctor of science, *causa honoris*, and invest you with all the rights and privileges appertaining to that degree.

You, Sir Knight, come to us as the honored delegate from venerable Rome, and as the official representative of sunny Italy, a land rich in history, from the time of the Renaissance a world leader in literature and art. The genius of your people has enriched our national character as thousands of your countrymen have merged their lives with ours. Cesare Longobardi, doctor of laws of the University of Naples, Sir Knight of the Crown, chief of section of the statistical bureau of the International Institute of Agriculture, in honor of your native land, in admiration of your personal courage and valor attested by your country's medal for military valor and cross for merit in war, and in recognition of your outstanding administrative talents and meritorious achievements, I gladly admit you to the degree of doctor of laws, *causa honoris*, and invest you with all the rights and privileges appertaining to that degree.

Charles Porcher, Chevalier of the Legion of Honor, you come to us from France, godmother of America in her early infancy; the historic friendship of your nation and ours was deepened by the blood fellowship of your recent sacrificial years; thousands of our bravest and best sleeping on the bosom of your beautiful but scarred land knit us to you by sacred ties. Because you are serving with distinction as chief of the department of physics, chemistry, toxicology, and pharmacology at the National Veterinary School of France; because your work as editor and author so clearly attests scholarship and eminence in your special field of science; because you officially represent the National Dairy Federation, and because you are from France, I gladly admit you to the degree of doctor of science, *causa honoris*, and invest you with all the rights and privileges appertaining to that degree.

The twain do meet, East meets West, the Occident salutes the Orient. Proud indeed are we to join hands with our young sister nation across the Pacific, whose name must forever symbolize our fellowship, and we honor ourselves in honoring the official representative of the Flowery Kingdom to the World's Dairy Congress. You are accredited to us as a cultured gentleman, a mature scholar, a prominent and progressive leader in agricultural and industrial chemistry, and an author of repute in your chosen field of science. In appreciation of these attainments and of the nation you represent, I gladly admit you, Masayoshi Sato, doctor of philosophy of Hokkaido University, Bearer of the Order of Merit of the Japanese Empire, to the degree of doctor of science, *causa honoris*, and invest you with all the rights and privileges appertaining to that degree.

We welcome you, sir, as a worthy representative of Mother England—mother of nations, mother of men—whose sons throughout the world ever uphold her high traditions and safeguard civilization. To our common language, literature, religion, institutions, and ideals, is added that family affection which occasionally indulges the intimate privilege of mutual frankness. Robert Stenhouse Williams, bachelor of science of Edinburgh, doctor of medicine, doctor of public health of Cambridge, eminent researcher and teacher, all our rich heritage from old England adds to our enthusiasm as, out of our respect for your outstanding attainments as a scholar and scientist, and for your signal achievements in the field of bacteriology, we gladly admit you to the degree of doctor of science, *causa honoris*, and invest you with all the rights and privileges appertaining to that degree.

Sir Arnold Theiler, Knight Commander of St. Michael and St. George, Chevalier of the Crown of Belgium, doctor of veterinary medicine of the University of Bern, doctor of science of the University of the Cape of Good Hope, born and educated in Switzerland, you come to us after 32 years of citizenship and educational leadership in the Transvaal as the representative of

the Union of South Africa, that young and sturdy unit in the world-encircling group of independent nations federated in the great British Empire. During those years you have become worthily famous as Government surgeon and bacteriologist, as professor of pathology, as dean of the faculty of veterinary science of Transvaal University, and as author of scientific treatises on tropical diseases. Syracuse University but recognizes the achievements of your service in the distant southland of the vast continent of Africa as I gladly admit you to the degree of doctor of science, *causa honoris*, and invest you with all the rights and privileges appertaining to that degree.

Hubert Everett Van Norman, professor of dairy management and dean of the University Farm School of the University of California, you have been presented to me by one of Syracuse's foremost citizens, the president of the board of trustees of Syracuse University, on behalf of the city as well as of the university, and I am sure I may assume you are presented also with cordiality and unanimity by all the delegates of the World's Dairy Congress. In the field of scholarship you have attained merited fame as a teacher and administrator, as researcher and author, and, further, you have led science from the classroom and laboratory into fields of practical service. In addition, you have manifested exceptional executive ability and a rare genius for leadership. Not less for what you are in yourself—gentleman, scholar, teacher, organizer, and administrator—which alone makes you eminently worthy, but also as president of the National Dairy Association and as president of the World's Dairy Congress, I gladly admit you to the degree of doctor of laws, *causa honoris*, and invest you with all the rights and privileges appertaining to that degree, and heartily welcome you and your colleagues of this morning into the fellowship of the alumni of Syracuse University.

After the last session of the congress in Syracuse, a dinner was tendered to the foreign delegates, by the American dairy industry, Wednesday evening, October 10, 1923. The cordial appreciation of the foreign delegations of the various hospitalities which had been extended to them throughout the duration of the congress was expressed in farewell addresses, and by the presentation of a tea service of silver to the president of the World's Dairy Congress, Dr. Van Norman, and Mrs. Van Norman. The speakers were: Dr. F. E. Posthuma, the Netherlands; Mr. Arturo Pimentel, Argentina; Dr. A. Miyawaki, Japan; Mr. M. A. O'Callaghan, Australia; Dr. Cesare Longobardi, Italy; Dr. Robert Burri, Switzerland; Dr. Gerald Leighton, Scotland; Dr. Haakon Isaachsen, Norway; and Mr. J. A. Ruddick, Canada.

The presentation of the tea service was made by Mr. Frederik Benzinger, of Sweden, and Miss Dora G. Saker, of England, as spokesmen for the donors. Mrs. František Rozinek, of Czechoslovakia; Mrs. S. Orla-Jensen, of Denmark; and Mr. Manod Owen, of Wales, rendered songs in their native tongues.

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[The financial support of these members made the World's Dairy Congress possible.]

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 American Jersey Cattle Club, New York, N. Y.
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 California Dairy Council, San Francisco, Calif.
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 The Distributors' Association (Inc.), Seattle, Wash.
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 Seattle Milk Shippers' Association, Seattle, Wash.
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 United Dairy Association of Washington, Seattle, Wash.
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 Virginia State Guernsey Breeders' Association, Oakton, Va.

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 Fairmont Creamery Co., Omaha, Nebr.
 Grove City Creamery, Grove City, Pa.
 Macon Creamery Co., Macon, Mo.
 George C. Mansfield Co., Milwaukee, Wis.
 Mistletoe Creameries, Fort Worth, Tex.
 Swift & Co., Chicago, Ill.
 Wichita Creamery Co., Wichita, Kans.

CHEESE.

Hasselbeck Cheese Co., Buffalo, N. Y.

CONCENTRATED MILKS.

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 The Helvetia Co., St. Louis, Mo.
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 Hydrox Co., Chicago, Ill.
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 Thomas J. May Co., New York, N. Y.
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 Brook Hill Farm, Genesee Depot, Wis.
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 Pleasant View Farm, Waukesha, Wis.
 Producers' Dairy Co., Brockton, Mass.
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 S. M. Shoemaker, Ecclestone, Md.
 Tully Farms, Tully, N. Y.
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 Forest Glen Creamery Co., Chicago, Ill.
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 Illinois Dairy Co., Springfield, Ill.
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 Janssen Dairy Co., (Inc.), Hoboken, N. J.
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 Johnson Pure Milk Co., Minneapolis, Minn.
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 Kalamazoo Creamery Co., Kalamazoo, Mich.
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 Royal Ice Cream Co., Tacoma, Wash.
 Russell Creamery Co., Superior, Wash.
 St. Lawrence Dairy Co., Reading, Pa.
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 Sanitary Gold Seal Dairy Co., Los Angeles, Calif.
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 The Telling-Belle Vernon Co., Cleveland, Ohio.

STORAGE.

L. B. Kilbourne, Chicago, Ill.

Merchants Refrigerating Co., New York, N. Y.

PUBLISHERS.

Frederick C. Mathews Co., Detroit, Mich.

DAIRY PRESS.

Butter, Cheese and Egg Journal, Milwaukee, Wis.
 The Dairy World, Chicago, Ill.
 Hoard's Dairyman, Fort Atkinson, Wis.
 The Ice Cream Review, Milwaukee, Wis.

The Ice Cream Trade Journal, New York, N. Y.
 The Jersey Bulletin, Indianapolis, Ind.
 The Milk Dealer, Milwaukee, Wis.
 New York Produce Review, New York.

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 York Milk Machinery Co., York, Pa.

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DELEGATES TO THE CONGRESS.

[Registration: Foreign, 231; United States, 1,590: total, 1,821. Delegates arranged alphabetically by nations.]

ALBANIA.

*Dr. C. Telford Erickson, 1527 Rhode Island Avenue, NW., Washington, D. C.

ARGENTINA.

*Gustavo Casares, Ministry of Agriculture, Buenos Aires.
 *Ricardo M. Pearson, jr., Ministry of Agriculture, Buenos Aires.
 *Arturo Pimentel, Ministry of Agriculture, Buenos Aires.
 *Ernesto M. Quintana, Ministry of Agriculture, Buenos Aires.

ARMENIA.

H. G. Movsesyan, 22 Stradalira, Rustchuck, Bulgaria.

AUSTRIA.

*Dr. Ernst A. Hauser, 14 Schwindgasse, Vienna.

BELGIUM.

Leon Geenens, National Society of Dairying, Quai des Moines, Gand.
 Dr. J. Maquet, Belgian Administration of Hygiene, Ministry of Interior; also representing C. R. B. [formerly Commission for the Relief of Belgium] Educational Foundation (Inc.), Brussels.

BOLIVIA.

*Zavier Paz Campero, Bolivian Legation, Washington, D. C.

BRAZIL.

*Dr. Aleixo de Vasconcellos, chief of milk section, Ministry of Agriculture, Rio de Janeiro.

CHILI.

*Carlos Ramirez, Agricultural Institute of Santiago, Santiago.
 Tomas Eastman, Wessell, Duval & Co., Valparaiso.

CHINA.

*Tsahnyeon Philip Sze, Chinese Consulate General, 13 Astor Place, New York City.

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*Dr. Antonio Pena Chavarria, 712 St. Paul Street, Baltimore, Md.
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CUBA.

Dr. Vicente E. Amer, Ciego de Avila.
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 *Dr. Rafael de Castro, chief of Department of Veterinary Medicine and Animal Husbandry, Department of Agriculture, Habana.
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CZECHOSLOVAKIA.

*Dr. Rudolph Kuráž, secretary of legation, Washington, D. C.
 *Dr. František Rozinek, Ministry of Health, Prague.

DENMARK.

*Dr. C. E. Bloch, Department of Health, Rigshospitalet, Copenhagen.
 *Anton Christensen, Royal Agricultural College, Copenhagen.
 *M. Christiansen, Royal Agricultural College, Copenhagen.
 Johannes Hansen, president, Chr. Hansen's Laboratory (Inc.), Copenhagen.
 *Prof. S. Orla-Jensen, Royal Technical College, Copenhagen.
 Mrs. S. Orla-Jensen, Royal Technical College, Copenhagen.
 *S. Sørensen, agricultural attaché, Danish Legation, 422 Southern Building, Washington, D. C.

DOMINION REPUBLIC.

*Emilio C. Jouhert, Dominican Legation, Washington, D. C.

FINLAND.

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FRANCE.

*Prof. Ch. Porcher, editor in chief, Le Lait, 2 Quai Chauveau, Lyon.
 Henri Cassou, export agent, Agricultural Society of Southeastern France, 82 Rue Rambuteau, Paris.

GERMANY.

Paul Funke, Paul Funke & Co., G. M. B. H. Berlin.
 Dr. Ernst Philippe, Milchwerke Angela Kappeln, Schleswig-Holstein.
 Eduard Sethe, 11 Broadway, New York City.

GREAT BRITAIN.**AUSTRALIA.**

M. A. O'Callaghan, dairy expert, Federal Government, Melbourne.
 Hon. Donald Mackinnon, Australian commissioner in the United States, 44 Whitehall Street, New York City.

CANADA.

J. H. Armitage, Guaranteed Pure Milk Co., Montreal, Quebec.
 M. T. Armitage, Sherbrooke Pure Milk Co., Sherbrooke, Quebec.
 J. T. Arrell, Hamilton Health Department, Hamilton, Ontario.
 Arthur Benoit, B. Trudel & Co., Montreal, Quebec.
 John Bingham, Ottawa Dairy (Ltd.), Ottawa, Ontario.
 E. Bourbeau, Quebec Ministry of Agriculture, St. Hyacinthe, Quebec.
 Frank Boyes, Dairymen's Association of Western Ontario, Dorchester, Ontario.
 Jas. Breslow, Western Dairy (Ltd.), St. Thomas, Ontario.
 R. W. Brown, Manitoba Agricultural College, Winnipeg, Manitoba.
 T. G. Brown, Wentworth Dairy Co. (Ltd.), Hamilton, Ontario.
 Bartley Bull, National Dairy Council of Canada, Brampton, Ontario.
 Robert Cairns, The Farmers' Dairy Co. (Ltd.), Toronto, Ontario.
 Helen G. Campbell, Dairy & Cold Storage Branch, Ottawa, Ontario.
 James Gordon Carruthers, The Farmers' Dairy Co. (Ltd.), Toronto, Ontario.
 Wm. G. Caulfield, Caulfield & Sons (Ltd.), Toronto, Ontario.
 Napoleon Charest, J. J. Joubert (Ltd.), Montreal, Quebec.
 Dr. A. T. Charron, Provincial Ministry of Agriculture, St. Hyacinthe, Quebec.
 C. Christensen, Caledonia, Ontario.
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 H. H. Dean, Ontario Agricultural College, Guelph, Ontario.
 R. W. Dockeray, Acme Dairy (Ltd.), Toronto, Ontario.
 W. D. C. Donaldson, Ontario Agricultural College, Guelph, Ontario.
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 Henry Downs, Brass Foundry Works, Lemmoxville, Quebec.
 Lloyd W. Fegan, The Farmers' Dairy Co. (Ltd.), Toronto, Ontario.
 Andre Remi Fetreault, The J. B. Ford Co., Montreal, Quebec.
 Thos. H. Gamble, Ottawa Dairy (Ltd.), Ottawa, Ontario.
 A. L. Gibson, Ontario Agricultural College, Guelph, Ontario.
 D. Z. Gibson, Caledonia Dairies, Caledonia, Ontario.
 L. A. Gibson, Manitoba Government, Parliament Building, Winnipeg, Manitoba.
 Jules Gingras, Laiterie de Quebec, Quebec, Quebec.

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K. F. Meyer, Berkeley, Calif.

W. M. Regan, Davis, Calif.

C. L. Roadhouse, Davis, Calif.

California Dairy Council:

D. M. Dorman, Los Angeles, Calif.
 Geo. R. Frampton, Artesia, Calif.
 J. J. Frey, Sacramento, Calif.
 C. E. Gray, San Francisco, Calif.
 Sam H. Green, San Francisco, Calif.
 L. M. Powers, Los Angeles, Calif.
 C. L. Roadhouse, Davis, Calif.

California Farm Bureau:

G. E. Gordon, Los Angeles, Calif.

California Guernsey Breeders' Association:

James A. Brown, Capitola, Calif.

California Holstein-Friesian Association:

H. Michel, Santa Monica, Calif.

California Jersey Cattle Club:

J. W. Coppini, Ferndale, Calif.

California Milk Distributors' Association:

Hugh Boyle, Los Angeles, Calif.

D. M. Dorman, Los Angeles, Calif.

H. Michel, Santa Monica, Calif.

C. L. Roadhouse, Davis, Calif.

California Milk Producers' Association:

T. H. Brice, Los Angeles, Calif.

Cannon Supply Co.:

K. Q. Cannon, Salt Lake City, Utah.

Carnation Milk Products Co.:

C. Albert Altwegg, Oconomowoc, Wis.

William C. Cross, Sherman, N. Y.

Geo. Grindrod, Oconomowoc, Wis.

Daniel F. Horton, Chicago, Ill.

Walter Page, Oconomowoc, Wis.

Castanea Dairy Co.:

E. B. Morrell, Pennington, N. J.

A. M. Woodward, Trenton, N. J.

Cayuga County Holstein Club:

J. Reynolds Wait, Auburn, N. Y.

Cedarburg Dairy Co.:

Henry Bemis, Milwaukee, Wis.

Central of Georgia Railway Co.:

J. F. Jackson, Savannah, Ga.

Central Pennsylvania Guernsey Breeders' Association:

L. L. Peery, LaFayette, Ind.

Central Shuey Co.:

Robt. A. Shuey, Oakland, Calif.

Certified Milk Producers' Association:

Wilson H. Lee, New Haven, Conn.

Certified Seed Association:

Joseph M. Hurley, Syracuse, N. Y.

Challenge Cream & Butter Association:

C. L. Mitchel, Los Angeles, Calif.

Chapin-Sacks Corporation:

Chas. E. Krey, Washington, D. C.

A. R. Sanna, Washington, D. C.

Cherry-Bassett-Winner Co.:

J. H. Ashmead, Philadelphia, Pa.

S. B. Ashmead, Philadelphia, Pa.

Jas. B. Morse, Baltimore, Md.

H. T. Winner, Philadelphia, Pa.

J. G. Cherry Co.:

Howard Cherry, Cedar Rapids, Iowa.

W. L. Cherry, Cedar Rapids, Iowa.

R. S. Damuth, Cedar Rapids, Iowa.

W. C. Hoeltze, St. Paul, Minn.

W. R. McEwen, Cedar Rapids, Iowa.

G. H. Tellier, Cedar Rapids, Iowa.

Chesapeake & Ohio Railway Co.:

K. T. Crawley, Richmond, Va.

Chester County Holstein-Friesian Breeders' Association:

F. C. Brinton, jr., West Chester, Pa.

Chicago, Milwaukee & St. Paul Railway Co.:

W. D. Carrick, Milwaukee, Wis.

Chicago & Alton Railroad Co.:

S. G. Lutz, Chicago, Ill.

Chicago & Northwestern Railway Co.:

Ford J. Allen, Chicago, Ill.

Chicago Dairy Produce:

J. Nielson-Lange, Chicago, Ill.

Chicago Great Western Railroad Co.:

David W. Quick, Philadelphia, Pa.

H. C. Christians Co.:

Arthur Medwedeff, Baltimore, Md.

Christiansen Brothers Dairy Co.:

Arnold E. Christiansen, Chicago, Ill.

Cincinnati Milk Exchange of the Chamber of Commerce:

H. D. Hooge, Cincinnati, Ohio.

City Consumers' Co.:

Chas. G. Vahlkamp, Paducah, Ky.

Clemson Agricultural College:

S. S. Bee, Charleston, S. C.

C. G. Cushman, Spartanburg, S. C.

I. R. Jones, Friendsville, Pa.

Fred C. Shelton, Aiken, S. C.

Cleveland Bureau of Food and Dairy Inspection:

Roy F. Leslie, Cleveland, Ohio.

Cleveland Dairy Products Co.:

George A. Villere, New Orleans, La.

Clover Leaf Milling Co.:

F. C. Greutker, Buffalo, N. Y.

Harry M. Knox, Buffalo, N. Y.

Colorado, State of:

H. R. Lascelles, Fort Collins, Colo.

W. H. Skitt, Greeley, Colo.

Colorado Holstein Association:

C. F. Louderback, Woodman, Colo.

Columbia University:

Henry C. Sherman, New York, N. Y.

Mary S. Rose, New York, N. Y.

Commerce, United States Department of:

Mary L. Bynum, Washington, D. C.

Margaret A. Wulfert, Washington, D. C.

Connecticut, State of:

R. A. Ayer, Hartford, Conn.

C. D. Blanchard, Hartford, Conn.

H. O. Daniels, Hartford, Conn.

Geo. T. Fowler, New Haven, Conn.

J. C. Gilbert, Hartford, Conn.

R. A. Haines, Hartford, Conn.

Thomas Holt, Hartford, Conn.

F. H. Page, Hartford, Conn.

F. H. Paine, Hartford, Conn.

W. J. Warner, Hartford, Conn.

Connecticut Agricultural College:

L. M. Chapman, Storrs, Conn.

James J. Clark, Storrs, Conn.

R. C. Fisher, Storrs, Conn.

Donald B. Humphrey, Storrs, Conn.

A. C. Hotchkiss, Storrs, Conn.

Lloyd W. Kenneth, Storrs, Conn.

Arthur R. Merrill, Storrs, Conn.

G. C. White, Storrs, Conn.

Raymond E. Wing, Storrs, Conn.

Connecticut Dairy and Food Council:

Dorothy S. Buckley, Hartford, Conn.

B. W. Ellis, Storrs, Conn.

Viola A. Ericson, Hartford, Conn.

Gladys V. Goldthorpe, New Haven, Conn.

Connecticut Dairymen's Association:

J. G. Schwink, Meriden, Conn.

Connecticut Holstein-Friesian Breeders' Association:

W. S. Kellogg, Derby, Conn.

Connecticut Milk Producers' Association:

George W. Harris, Wethersfield, Conn.

C. E. Hough, New Haven, Conn.

Robert C. Mitchell, Southbury, Conn.

C. P. Viets, Hartford, Conn.

Connecticut State Grange:

Allen B. Cook, Niantic, Conn.

Connor Ice Cream Co. (Inc.):

Jos. G. Matthews, Ovid, Mich.

Consumers' Dairy Co.:

Otto Heuer, Union Hill, N. J.

Fred Wolpmann, Union Hill, N. J.

Continental Can Co. (Inc.):

Albert P. Jacobs, Syracuse, N. Y.

Cornell University:

Bristow Adams, Ithaca, N. Y.

Sadye F. Adelson, Ithaca, N. Y.

C. L. Allen, Ithaca, N. Y.

W. E. Ayres, Ithaca, N. Y.

Jessie A. Boys, Ithaca, N. Y.

Elva T. Campbell, Ithaca, N. Y.

Erna B. Christy, Ithaca, N. Y.

Bertine Collins, Ithaca, N. Y.

J. N. Frost, Ithaca, N. Y.

H. A. Hopper, Ithaca, N. Y.

A. R. Mann, Ithaca, N. Y.

E. G. Misner, Ithaca, N. Y.

Helen Monsch, Ithaca, N. Y.

M. P. Moon, Ithaca, N. Y.

V. A. Moore, Ithaca, N. Y.

Flora Rose, Ithaca, N. Y.

Cornell University—Continued.

Adelaide Spohn, Ithaca, N. Y.
 W. A. Stocking, Ithaca, N. Y.
 Flora M. Thurston, Ithaca, N. Y.
 D. H. Udall, Ithaca, N. Y.
 Martha Van Rensselaer, Ithaca, N. Y.
 W. L. Williams, Ithaca, N. Y.
 H. H. Wing, Ithaca, N. Y.

Crane Ohio Ice Cream Co.:

H. C. Moores, Columbus, Ohio.
 H. E. Otting, Columbus, Ohio.
 S. M. Ross, Columbus, Ohio.

Creamery Package Manufacturing Co.:

E. W. Chandler, Chicago, Ill.
 R. F. Davis, Chicago, Ill.
 Hewitt S. Dixon, Chicago, Ill.
 N. C. Tompkins, Chicago, Ill.
 E. F. Wellinghoff, Chicago, Ill.
 G. W. Williams, Chicago, Ill.

Crescent Creamery Co.:

S. A. W. Carver, Los Angeles, Calif.
 W. B. Edson, Los Angeles, Calif.
 H. W. Ferguson, Los Angeles, Calif.
 Herbert Sponholz, Los Angeles, Calif.

Crowley's Milk Co.:

J. K. Crowley, Binghamton, N. Y.

Crystal Ice and Storage Co.:

Geo. W. Burt, Portland, Oreg.

Francis S. Cummings Co.:

A. W. Cary, Somerville, Mass.
 John Colgan, Somerville, Mass.

Dairy Delivery Co.:

Sheldon Perham, San Francisco, Calif.
 A. L. Stone, San Francisco, Calif.

The Dairy Farmer:

C. A. Goss, Des Moines, Iowa.

Dairymen's Cooperative Sales Co.:

Harry I. Berlovich, Pittsburgh, Pa.
 W. W. Bullard, Andover, Ohio.
 Jane E. Davis, Pittsburgh, Pa.
 E. F. Nohle, N. Jackson, Ohio.
 Jas. M. Paxton, Houston, Pa.
 John L. Wise, Harmony, Pa.

Dairymen's League Cooperative Association (Inc.):

C. A. Boutelle, Richfield Springs, N. Y.
 Dewey J. Carter, New York, N. Y.
 A. C. Colter, Watertown, N. Y.
 Harry M. Epped, Accord, N. Y.
 Harry J. Ferguson, Oneonta, N. Y.
 S. Q. Grady, New York, N. Y.
 Frank Gurnsey, Hackettstown, N. J.
 C. F. Hawes, New York, N. Y.
 Fred A. Hoar, New York, N. Y.
 D. W. Hodges, Utica, N. Y.
 Harold N. Humphrey, Jamestown, N. Y.

Vera L. McCrea, New York, N. Y.
 A. L. Milks, Little Valley, N. Y.
 Herman H. Otto, Scranton, Pa.
 J. G. Petherbridge, Middletown, N. Y.
 R. J. Quackenbush, Cornwall-on-Hudson, N. Y.

W. V. Rixford, Wellsville, N. Y.
 E. D. Russ, Clinton, N. Y.

E. H. Russell, Springville, N. Y.

William A. Schreyer, New York, N. Y.

Fred H. Sexauer, Auburn, N. Y.

Chas. A. Shepard, Herkimer, N. Y.

George W. Slocum, New York, N. Y.

Fred D. Smith, Ithaca, N. Y.

Paul Smith, Newark Valley, N. Y.

W. L. Stewart, Burke, N. Y.

T. H. Townsend, Utica, N. Y.

Roy H. Van Scoik, Utica, N. Y.

Paul C. Waters, Worcester, N. Y.

Dairymen's League News:

Oliver E. Everett, New York, N. Y.

Dairymen's Milk Producers' Co.:

L. B. Cannon, Anniston, Ala.

Dallas Health Department:

J. A. Holzman, Dallas, Tex.

Danbury Creamery and Haviland Dairy:

H. A. W. Schneyer, Danbury, Conn.

Danish Creamery Association:

J. R. Murphy, Fresno, Calif.

The Davis Co.:

W. H. Davis, Newark, Ohio.

B. W. Snyder, Newark, Ohio.

De Laval Pacific Co.:

Leonard T. Kitts, San Francisco, Calif.
 Thomas Stead, Berkeley, Calif.

De Laval Separator Co.:

E. W. Carter, Chicago, Ill.

Defiance Dairy Products Co.:

Maurice R. Myers, Defiance, Ohio.

The Deis-Fertig Dairies Co.:

George E. Fertig, Dover, Ohio.

Delaware, State of:

Henry F. Du Pont, Winterthur, Del.

Delaware, Lackawanna & Western Railroad Co.:

Frank Cizek, Binghamton, N. Y.

D. T. Lawrence, New York, N. Y.

Allen S. Merchant, Binghamton, N. Y.

Frank H. Pyke, Syracuse, N. Y.

G. E. Zippel, Hoboken, N. J.

Detroit Creamery Co.:

N. J. Dessert, Detroit, Mich.

Detroit Department of Health:

C. H. Chilson, Detroit, Mich.

H. Cornell, Detroit, Mich.

G. W. Jordau, Detroit, Mich.

S. Lyons, Detroit, Mich.

Clifton O. Myll, Detroit, Mich.

Edwin J. Smith, Detroit, Mich.

H. W. Welsh, Detroit, Mich.

Thomas G. White, Detroit, Mich.

E. H. Wines, Detroit, Mich.

Dewart Milk Products Co.:

F. H. Maurer, Williamsport, Pa.

D. R. Rayn, Dewart, Pa.

Dewey J. Riffel, Dewart, Pa.

J. M. Dingle Co.:

John J. Dingle, Erie, Pa.

The Distributors' Association (Inc.):

A. F. Bird, Seattle, Wash.

A. T. Hansley, Seattle, Wash.

District of Columbia:

Ford E. Young, Washington, D. C.

Douthitt Engineering Co.:

F. H. Douthitt, Chicago, Ill.

The Dry Milk Co.:

V. J. Ashbaugh, Adams, N. Y.

L. J. Auerbacher, New York, N. Y.

Louis J. Auerbacher, jr., New York, N. Y.

H. P. Fel, New York, N. Y.

G. C. Supplee, New York, N. Y.

East Bay Creamery Co.:

H. W. Low, Oakland, Calif.

Eden-Collins-Concord Dairy Association:

E. St. J. Baldwin, Brooklyn, N. Y.

Elite Ice Cream Co.:

S. A. Gastin, Shenandoah, Pa.

Elizabeth Health Department:

John J. Coughlin, Elizabeth, N. J.

Elyria Enameled Products Co.:

Harry S. Calvert, Elyria, Ohio.

D. B. Etters, Elyria, Ohio.

J. E. Simpson, Chicago, Ill.

Erie Railroad Co.:

W. L. Kendall, Oak Park, Ill.

H. B. Rogers, Jamestown, N. Y.

W. M. Evans Dairy Co. (Inc.):

W. C. Evans, Brooklyn, N. Y.

Evansville Pure Milk Co.:

Roy S. Atkinson, Evansville, Ind.

C. J. Meyer, Evansville, Ind.

G. L. Ogle, Evansville, Ind.

D. H. Ewing's Sons:

C. Oscar Ewing, Louisville, Ky.

Tilford A. Ewing, Louisville, Ky.

H. H. Neel, Louisville, Ky.

Excelsior Creamery Co.:

R. M. Wyckoff, Santa Ana, Calif.

Fairfield Farms Dairy, (Inc.):

Russell B. Fulton, Mount Washington, Md.

J. C. Jones, Baltimore, Md.

Leon Mitchell, Baltimore, Md.

Lawrence Wooden, Baltimore, Md.

Fairmont Creamery:

Donald K. Howe, Omaha, Nebr.:

Faithoute Iron & Steel Co.:

M. W. Faithoute, Newark, N. J.

Fall River Milk Dealers' Association:

W. E. Peckham, Fall River, Mass.

- Farm and Home :
A. W. Fulton, Springfield, Mass.
- The Field Illustrated :
Joseph Mangeot, Fulton, N. Y.
- Fitchett Bros. :
John S. Fitchett, Poughkeepsie, N. Y.
- Florida, University of :
Hamlin L. Brown, Gainesville, Fla.
C. H. Willoughby, Gainesville, Fla.
- Florida East Coast Railway Co. :
H. S. McLendon, St. Augustine, Fla.
- Flynn Dairy Co. :
R. D. Lawyer, Des Moines, Iowa.
- Foland's Dairy :
Henry W. Foland, Bridgeport, Conn.
- J. B. Ford Co. :
E. C. Beardsley, Baltimore, Md.
D. P. Dozier, Wyandotte, Mich.
Vern R. Jones, Wyandotte, Mich.
J. J. Harris, Wyandotte, Mich.
T. J. Woolsey, Baltimore, Md.
- Forrest Glen Creamery Co. :
Claus Junge, Round Lake, Ill.
P. Edward Riley, Chicago, Ill.
T. J. Riley, Chicago, Ill.
- Fort Wayne Dairy Co. :
H. R. Spurling, Fort Wayne, Ind.
- Fraim's Dairies :
Clarence Fraim, Wilmington, Del.
- Franklin Cooperative Creamery Association :
H. I. Nordby, Minneapolis, Minn.
Edward Solem, Minneapolis, Minn.
- Franklin County Extension Service :
Mrs. Mary J. Harris, Deerfield, Mass.
E. J. Montague, Amherst, Mass.
- The Frechtling Dairy Co. :
C. H. Keating, Hamilton, Ohio.
- Frederick (Md.) Farm Bureau :
David G. Zentz, Thurmont, Md.
- Freeman Dairy Co. :
Leonard Freeman, Flint, Mich.
E. C. Hollingsworth, jr., Flint, Mich.
- Fucoma Co. :
Ernest Ritter, New York, N. Y.
C. Richard Schenk, New York, N. Y.
- Galesville Creamery :
John Norgaard, Galesville, Wis.
- Galliker Ice Cream Co. :
Louis Galliker, Johnstown, Pa.
- Galloway-West Co. :
M. E. West, Fond du Lac, Wis.
W. A. West, Elk Horn, Wis.
- Gibson Oat Crusher Co. :
Charles Hottes, New York, N. Y.
- Glass Container Association :
S. Henry Ayers, New York, N. Y.
- Golden Churn Brand Butter Color Laboratories :
L. Aldler, St. Louis, Mo.
- Golden State Milk Products Co. :
A. M. Besemer, Eureka, Calif.
Frank E. Buck, San Francisco, Calif.
C. E. Gray, San Francisco, Calif.
B. H. Rawl, San Francisco, Calif.
- Golden State Sales Corporation :
C. E. Buell, Boston, Mass.
C. W. Burckhalter, New York, N. Y.
A. E. Paulsen, New York, N. Y.
F. J. Widenhorn, New York, N. Y.
- Goldsboro, Wayne County, Health Department :
A. H. Kern, Goldsboro, N. C.
- Gossard Breeding Estates :
H. W. Gossard, Martinsville, Ind.
J. H. Stowell, Martinsville, Ind.
- Grand Trunk Line :
W. A. Lally, Chicago, Ill.
- Gray Milk Products Co. :
C. E. Fenlon, East Gray, Wis.
- Gray Von Allmen Sanitary Milk Co. :
Otto Von Allmeu, Louisville, Ky.
- Great Lakes Transit Corporation :
J. M. Coonau, Duluth, Minn.
W. J. Meagher, Buffalo, N. Y.
- Great Northern Railway Co. :
Ralph Budd, St. Paul, Minn.
- Greenwich Department of Health :
Earle F. Schofield, Greenwich, Conn.
- Gridlev Dairy Co. :
Charles Clofine, Philadelphia, Pa.
James H. Hobson, Chicago, Ill.
Frank W. Kelly, Milwaukee, Wis.
John Le Feber, Milwaukee, Wis.
Lester Le Feber, Milwaukee, Wis.
Carl E. Lee, Milwaukee, Wis.
- Gude Bros., Kieffer Co. :
P. H. Kieffer, New York, N. Y.
- Guernsey Breeders' Association of Western Pennsylvania :
John J. Costoff, Sharpsburg, Pa.
Ralph E. Flinn, Sharpsburg, Pa.
- Guernsey Cattle Club of Madison County, N. Y. :
Henry Burden, Cazenovia, N. Y.
- Hampton Normal and Agricultural Institute :
William R. Jackson, Hampton, Va.
Eldon S. Moberg, Hampton, Va.
John A. Vohringer, Hampton, Va.
- T. G. Hancock Co. :
T. G. Hancock, Chelsea, Mass.
- Hanover Creamery Co. :
H. M. Stokes, Hanover, Pa.
- Hansen Dairy Co. :
O. W. Strodthoff, Los Angeles, Calif.
- Chr. Hansen's Laboratory (Inc.) :
K. J. Monrad, Little Falls, N. Y.
- Harbison's Dairies :
R. Harbison, Philadelphia, Pa.
R. Harbison, jr., Philadelphia, Pa.
- Harmony Creamery Co. :
H. E. Houck, Gallipolis, Ohio.
T. P. Otto, Pittsburgh, Pa.
Edward M. Wilsou, Pittsburgh, Pa.
- Harris Bros. Dairy Co. :
A. R. Harris, Salt Lake City, Utah.
- Hawaii, Territory of :
Bertram G. Rivenburgh, Washington, D. C.
- Hazel Glen Milk Co. :
George E. Hastie, Pittsburgh, Pa.
- Henningsen Co. :
H. B. Hirsh, Butte, Mont.
- C. Heurich Bottling Works :
C. Heurich, Washington, D. C.
- Hiland Dairy Co. :
M. A. Maileuder, Newport, Ky.
Geo. B. Mook, Newport, Ky.
- Hoard's Dairyman :
Paul C. Burchard, Fort Atkinson, Wis.
A. J. Glover, Fort Atkinson, Wis.
- Hollingsworth Farms Co. :
R. E. Burger, South Bend, Ind.
- Holstein-Friesian Association of America :
E. A. Baker, Boston, Mass.
W. B. Barney, Chicago, Ill.
John A. Bell, jr., Pittsburgh, Pa.
R. E. Chapin, Batavia, N. Y.
Earl J. Cooper, Chicago, Ill.
A. N. Crissey, Salem, N. J.
Frank T. Fowler, Lake Villa, Ill.
F. L. Houghton, Brattleboro, Vt.
John B. Irwin, Minneapolis, Minn.
Fred A. Koenig, Chicago, Ill.
C. M. Long, Chicago, Ill.
H. A. Mathiesen, Salt Lake City, Utah.
W. S. Moscrip, Lake Elmo, Minn.
Dudley E. Waters, Grand Rapids, Mich.
Henry H. Wing, Ithaca, N. Y.
- Holstein-Friesian Association of Chester County, Pa. :
Frank A. Keen, West Chester, Pa.
- Holstein-Friesian Association of Mercer County, N. J. :
Donald B. Rice, Trenton, N. J.
- Holstein-Friesian World :
F. T. Price, Syracuse, N. Y.
- Holyoke Health Department :
Daniel F. Hartnett, Holyoke, Mass.
- H. P. Hood & Sons (Inc.) :
C. H. Hood, Boston, Mass.
Gilbert H. Hood, jr., Boston, Mass.
H. P. Hood, 2d, Boston, Mass.
Chester L. Nourse, Boston, Mass.

- Humboldt County Dairymen's Association:
J. W. Coppini, Ferndale, Calif.
- Hunter Walton & Co.:
Geo. B. Trimbull, New York, N. Y.
- Hutchinson Produce Co.:
C. E. Kester, Hutchinson, Minn.
- Hydrox Co.:
T. H. McInnerney, Chicago, Ill.
- The Ice Cream Trade Journal:
Robert C. Hibben, New York, N. Y.
- Idaho, State of:
L. C. Merrell, Boise, Idaho.
- Illinois, State of:
John T. Cunningham, Chicago, Ill.
L. Fred Muller, Rockford, Ill.
N. J. Nelson, Peoria, Ill.
B. S. Peatsall, Elgin, Ill.
H. A. Ruehe, Urbana, Ill.
F. E. Shuster, Springfield, Ill.
- Illinois, University of:
M. H. Campbell, Urbana, Ill.
W. B. Nevens, Urbana, Ill.
H. A. Ruehe, Urbana, Ill.
W. J. Fraser, Urbana, Ill.
- Illinois Agricultural Association:
A. D. Lyneh, Chicago, Ill.
- Illinois Association of Ice Cream Manufacturers:
T. H. McInnerney, Chicago, Ill.
- Illinois Central Railroad Co.:
H. J. Schwiectert, Chicago, Ill.
- Illinois Dairy Co.:
F. H. Kullman, Chicago, Ill.
- Illinois Milk Dealers' Association:
Peter C. Christiansen, Chicago, Ill.
F. H. Kullman, Chicago, Ill.
Wm. W. Wanzer, Chicago, Ill.
Charles Wieland, Chicago, Ill.
- Illinois State Dairymen's Association:
W. W. Marple, Chicago, Ill.
- Indiana Condensed Milk Co.:
Fred Riner, Lebanon, Ind.
- Indiana County Farm Bureau:
John W. Warner, Indiana, Pa.
- International Association of Dairy and Milk Inspectors:
Geo. E. Bolling, Brockton, Mass.
G. H. Grapp, Baltimore, Md.
Wm. H. Marcussen, New York, N. Y.
William H. Price, Detroit, Mich.
C. L. Roadhouse, Davis, Calif.
George B. Taylor, Washington, D. C.
Ivan C. Weld, Washington, D. C.
- International Milk Dealers' Association:
E. M. Bailey, Pittsburgh, Pa.
T. J. Bolitho, Chicago, Ill.
Mrs. T. J. Bolitho, Chicago, Ill.
C. Oscar Ewing, Louisville, Ky.
W. L. Johnson, Winthrop, Mass.
Elsie R. Larson, Chicago, Ill.
John Le Feber, Milwaukee, Wis.
R. E. Little, Chicago, Ill.
Thos. P. Otto, Pittsburgh, Pa.
C. H. Parker, Saginaw, Mich.
D. B. Peck, Chicago, Ill.
George A. Villere, New Orleans, La.
Frank A. Will, Philadelphia, Pa.
- International Salt Co.:
M. L. Hyman, Scranton, Pa.
- Interstate Milk Producers' Association:
H. D. Allebach, Philadelphia, Pa.
Robert W. Balderson, Philadelphia, Pa.
Robert F. Brinton, West Chester, Pa.
E. C. Dunning, Harrisburg, Pa.
Frederick Shangle, Philadelphia, Pa.
Asher B. Waddington, Philadelphia, Pa.
- Iowa, State of:
C. Beehtelheimer, Waterloo, Iowa.
W. L. Cherry, Cedar Rapids, Iowa.
R. G. Clark, Des Moines, Iowa.
C. R. Conway, Garner, Iowa.
M. Mortensen, Ames, Iowa.
E. M. Sherman, Charles City, Iowa.
- Iowa State Department of Agriculture:
M. E. McMurray, Des Moines, Iowa.
- Iowa State College of Agriculture and Mechanic Arts:
C. B. Finley, Ames, Iowa.
Porter Jarvis, Ames, Iowa.
Floyd Johnston, Ames, Iowa.
A. M. Kirby, Ames, Iowa.
R. F. Mygatt, Ames, Iowa.
R. A. Pearson, Ames, Iowa.
M. Mortensen, Ames, Iowa.
Earl Weaver, Ames, Iowa.
- Iowa Buttermakers' Association:
C. R. Conway, Garner, Iowa.
- Iowa Creamery Butter Manufacturers' Association:
C. G. Reeve, Ottumwa, Iowa.
- Iowa Dairy Co.:
A. Fluetsch, Dubuque, Iowa.
J. L. Hileman, Dubuque, Iowa.
- James Manufacturing Co.:
D. Q. Grabill, Fort Atkinson, Wis.
- Jamestown Health Department:
J. A. Hulquist, Jamestown, N. Y.
- Jensen Creamery Machinery Co.:
George V. Sheffield, Pompton Lakes, N. J.
Wm. M. Roscnale, New York, N. Y.
- Jersey Club of Otsego County:
W. H. Riddell, Maryland, N. Y.
- Jersey Ice Cream Co.:
Stephen W. Dyer, Lawrence, Mass.
- Jewell Ice Cream and Milk Co.:
R. M. Jewell, Mount Vernon, Ohio.
- Johnstown Sanitary Dairy Co.:
O. H. Fogelsanger, Johnstown, Pa.
- Journal of Dairy Science:
R. C. Fisher, Storrs, Conn.
E. F. Williams, Baltimore, Md.
- Kalamazoo Vegetable Parchment Co.:
John F. Sehllick, jr., Kalamazoo, Mich.
- Kansas, State of:
James W. Linn, Manhattan, Kans.
W. H. Mott, Herington, Kans.
- Kansas State Agricultural College:
H. W. Cave, Manhattan, Kans.
- Kansas State Board of Health:
Milton O. Nyberg, Topeka, Kans.
- Kansas City Consumers' League:
J. V. Quigley, Kansas City, Mo.
- Kansas City Health Department:
J. J. Glover, Kansas City, Mo.
J. W. Yates, Kansas City, Mo.
- Kansas Creamerymen's Improvement Association:
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- J. Karlen Cheese Co.:
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- Keiner Williams Stamping Co.:
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W. W. McEwen, Richmond Hill, N. Y.
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- Kenredy Dairy Co.:
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Sarah H. Vance, Louisville, Ky.
Chas. G. Vahlkamp, Paducah, Ky.
- Kentucky State Board of Health:
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- Kentucky, State University of:
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- Keystone Dairy Co.:
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- Kimble Glass Co.:
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Joseph T. Moran, Vineland, N. J.
- J. L. Kraft & Bros.:
L. C. Bowman, New York, N. Y.
Carl F. W. Gentner, Scranton, Pa.
John H. Kraft, Chicago, Ill.
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S. K. Robinson, Chicago, Ill.
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- Lacteal Analytical Laboratories (Inc.):
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- Lancaster Sanitary Milk Co.:
E. L. Garber, Lancaster, Pa.
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- Lehigh Valley Railroad Co.:
P. H. Burnett, New York, N. Y.
B. F. Dewey, New York, N. Y.
- Lentz Dairy Co.:
Charles N. Lentz, Chicago, Ill.
- Levring & Co. (Inc.):
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- Liberty Yeast Corporation:
H. V. Shelby, New York, N. Y.
- Long Beach Dairy Co.:
H. H. Low, Long Beach, Calif.
- Los Angeles Creamery Co.:
E. E. Balz, Philadelphia, Pa.
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- Louden Machinery Co.:
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- Louisiana Creamery (Inc.):
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- Louisville & Nashville Railroad Co.:
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H. E. Evans, Etowah, Tenn.
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- Maryland State Board of Health:
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- Maryland, University of:
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Carey F. Church, College Park, Md.
J. A. Conover, College Park, Md.
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- Maryland Agricultural Corporation:
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- Maryland Guernsey Breeders' Association:
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- Maryland Holstein-Friesian Breeders' Association:
Charles Wertheimer, Frederick, Md.
- Maryland State Dairymen's Association:
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R. Smith Snader, New Windsor, Md.
- Maryland and Virginia Milk Producers' Association:
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H. F. Judkins, Amherst, Mass.
- Massachusetts State Department of Agriculture:
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- Massachusetts Agricultural College:
David Hopkins, Amherst, Mass.
E. J. Montague, Amherst, Mass.
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- Massachusetts Farm Bureau Federation:
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George F. E. Story, Worcester, Mass.
- Massachusetts State Grange:
Ernest H. Gilbert, North Easton, Mass.
- The Marshall Dairy Laboratory:
A. L. Marshall, Madison, Wis.
- Frederick C. Mathews Co.:
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- Thomas J. May Co.:
Thomas J. May, New York, N. Y.
- Mead-Johnson & Co.:
Richard F. Keeler, Evansville, Ind.
- Meadow Brook Creamery Co. (Inc.):
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- Meister, Lulman & Stretch:
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- Memphis Department of Health:
C. L. Isley, Memphis, Tenn.
- Menzie Dairy:
John L. Laughlin, McKeesport, Pa.
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- Merchant Evans Co.:
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- Merton Dairy Products Co.:
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- Michigan Agricultural College:
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P. S. Lucas, East Lansing, Mich.
Charles D. Miller, Eaton Rapids, Mich.
G. L. A. Ruehle, East Lansing, Mich.
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- The Michigan Farmer:
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- Michigan State Holstein Association:
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- Mid-West Ice Cream Association:
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- The Milk Dealers' Fraternal League of Cleveland:
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- Milk Producers' Co.:
F. W. Sullivan, Battle Creek, Mich.
- Milk Producers' Review:
August A. Miller, Philadelphia, Pa.
- Milk Products Sales Co.:
H. E. Case, Cleveland, Ohio.
- Milwaukee County Holstein Breeders' Association:
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- Milwaukee Health Department:
S. L. Pilgrim, Milwaukee, Wis.
- Minneapolis, St. Paul & Sault Ste. Marie Railway Co.:
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C. S. Richardson, Buffalo, N. Y.
- Minnesota Farm Bureau:
John Brandt, Litchfield, Minn.
- Minnesota, State of:
John Brandt, Litchfield, Minn.
C. H. Eckles, St. Paul, Minn.
Chris Heen, St. Paul, Minn.
John B. Irwin, Minneapolis, Minn.
W. S. Moscrip, Lake Elmo, Minn.
D. D. Tenney, Minneapolis, Minn.
- Minnesota State Department of Agriculture:
J. H. Hay, St. Paul, Minn.

Minnesota State Dairy and Food Department:
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 C. D. Dahle, St. Paul, Minn.
 C. H. Eckles, St. Paul, Minn.
 J. R. Keithley, St. Paul, Minn.
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 H. Macy, St. Paul, Minn.
 L. S. Palmer, St. Paul, Minn.
 Russell W. Seath, Albert Lea, Minn.
 Minneapolis Tribune:
 Chas. F. Collisson, Minneapolis, Minn.
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 V. E. Gaskin, Aberdeen, Miss.
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 Mississippi Agricultural and Mechanical College:
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 E. M. Harmon, Columbia, Mo.
 A. J. McDowell, Springfield, Mo.
 Rudolph Miller, Macon, Mo.
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 Waverly P. Hays, Columbia, Mo.
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 Missouri Valley Creamery Co.:
 F. W. Springer, Washington, Mo.
 Missouri Pacific Railroad Co.:
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 Missouri, Kansas & Texas Railroad Co.:
 R. R. Walker, Dallas, Tex.
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 S. S. Lard, Fort Worth, Tex.
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 Mohawk Condensed Milk Co.:
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 Timothy Mojonnier, Chicago, Ill.
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The Nation's Health:
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 National Association of Dairy Supply Houses:
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 Fred N. Martin, Spokane, Wash.
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 J. D. Hollowell, Chicago, Ill.
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 M. D. Munn, Chicago, Ill.
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 Elsie Stark, Columbus, Ohio.
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 National Dairy Union:
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 Mrs. Bertha M. Loomis, Washington, D. C.
 J. R. Morley, Owatonna, Minn.
 Samuel Schlosser, Plymouth, Ind.
 National Enameling & Stamping Co.:
 William Rusche, Chicago, Ill.
 National Farmers' Union:
 A. B. Thornhill, Richmond, Va.
 National Fertilizer Association:
 Wm. D. Hurd, Washington, D. C.
 National Homogenizer Corporation:
 P. M. Travis, New York, N. Y.
 National Lime Association:
 John S. Slipper, Washington, D. C.
 National Milk Co.:
 Frank Bobrytzke, Chicago, Ill.
 National Milk Producers' Federation:
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 John D. Miller, Susquehanna, Pa.
 Richard Pattee, Boston, Mass.
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National Research Council:

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Alfred H. Engel, Lincoln, Nebr.

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H. P. Davis, Lincoln, Nebr.

Nevada, State of:

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New Haven Milk Bottle Exchange:

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New England Dairy and Food Council:

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W. P. B. Lockwood, Boston, Mass.

New England Dairymen:

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New England Milk Producers' Association:

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Mrs. R. W. Quackenbush, Cornwall-on-the-Hudson, N. Y.

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E. B. Lewis, New York, N. Y.

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D. C. Carpenter, Geneva, N. Y.

A. C. Dahlberg, Geneva, N. Y.

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G. J. Hucker, Geneva, N. Y.

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New York State Department of Health:

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Mabel T. McGuire, Albany, N. Y.

John F. Miller, Albany, N. Y.

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H. H. Wing, Ithaca, N. Y.

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Loton Horton, New York, N. Y.

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O. F. Soule, Syracuse, N. Y.

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W. P. Schanck, Avon, N. Y.

H. H. Wing, Ithaca, N. Y.

New York State Cheese Association:

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William F. Neureuter, Buffalo, N. Y.

J. F. Whitney, New York, N. Y.

New York State Creamery Association:

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New York State Dairymen's Association:

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New York State Federation of Home Bu-

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Mrs. A. W. Smith, Ithaca, N. Y.

New York State Grange:

Albert Manning, New York, N. Y.

F. J. Riley, Sennett, N. Y.

E. J. Walrath, Evans Mills, N. Y.

New York State Guernsey Breeders' Association:

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New York State Jersey Cattle Club:

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Newark Milk & Cream Co.:

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W. F. Noble & Sons Co.:

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J. R. Dice, Fargo, N. Dak.
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Northland Milk & Ice Cream Co.:

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C. F. Monroe, Wooster, Ohio.
A. E. Perkins, Wooster, Ohio.

Ohio State University:

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Oscar Erf, Columbus, Ohio.
W. H. Forsyth, Columbus, Ohio.
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S. M. Salisbury, Columbus, Ohio.
J. O. Tressler, Columbus, Ohio.

Ohio Association of Creamery Owners and Manufacturers:

W. H. Davis, Newark, Ohio.

Ohio Association of Ice Cream Manufacturers:

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John Schubach, Canton, Ohio.

Ohio Dairy Products Association:

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Ohio Farm Bureau Federation:

M. D. Lincoln, Columbus, Ohio.
E. D. Waid, Columbus, Ohio.

Ohio Farmer:

L. L. Rummell, Columbus, Ohio.

Ohio Farmers' Cooperative Association:

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Ohio Holstein-Friesian Association:

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Ohio Milk Distributors' Association:

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Oklahoma Agricultural and Mechanical College:

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A. D. Burke, Stillwater, Okla.
J. Noel Lowe, Stillwater, Okla.
J. B. Taylor, Stillwater, Okla.
Mead McWethy, Stillwater, Okla.

Oklahoma State Dairy Association:

John W. Boehr, Stillwater, Okla.

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A. M. Work, Portland, Oreg.

Oregon Agricultural College:

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Fred M. Knox, Corvallis, Oreg.
H. J. Olsen, Corvallis, Oreg.
J. C. Ostrom, Corvallis, Oreg.
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The Olsen Publishing Co.:

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A. J. Olson Co.:

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Orlando Health Department:

Jesse H. Hamilton, Orlando, Fla.

Pacific Northwest Milk Dealers' Association:

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Fred N. Martin, Spokane, Wash.

Pacific Slope Dairy Show:

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W. J. Pettee & Co.:

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Robert W. Balderston, Philadelphia, Pa.
John A. Bell, jr., Pittsburgh, Pa.
A. A. Borland, State College, Pa.
Hannah McK. Lyons, Philadelphia, Pa.
John D. Miller, Susquehanna, Pa.
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F. P. Weaver, State College, Pa.
W. R. Willett, State College, Pa.
Paul S. Williams, State College, Pa.

Pennsylvania State Department of Agriculture:

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Pennsylvania State Department of Health:

Ralph E. Irwin, Harrisburg, Pa.

W. W. White, Harrisburg, Pa.

Pennsylvania Breeders' and Dairymen's Association:

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A. A. Borland, State College, Pa.

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Pfaudler Co.:

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E. G. Miner, Rochester, N. Y.

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S. S. McCoy, New York, N. Y.
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Phenix Dairy:

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J. L. Starnes, Houston, Tex.

Pittsfield Milk Exchange:

Frank A. Carroll, Pittsfield, Mass.

Pittsburgh District Dairy Council:

Helen M. Bishop, Pittsburgh, Pa.
Lillian Cornwell, Pittsburgh, Pa.
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Irwin H. Kauffman, Pittsburgh, Pa.
E. R. Quackenbush, Pittsburgh, Pa.
Rebecca Rotstein, Pittsburgh, Pa.
Jane H. Sauer, Pittsburgh, Pa.
Marjorie Six, Pittsburgh, Pa.

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Philadelphia Interstate Dairy Council:

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Mrs. Robert W. Balderston, Philadelphia, Pa.

Myrtle L. Barger, Philadelphia, Pa.
Theodore C. Campbell, Metuchen, N. J.
C. I. Cohee, Philadelphia, Pa.

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Philadelphia Interstate Milk Association:

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- Port Jervis Board of Health:
W. Y. Rumsey, Goshen, N. Y.
- Portland-Damascus Milk Co.:
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- Portsmouth Department of Public Welfare:
C. A. Krause, Portsmouth, Va.
- Poughkeepsie Board of Health:
Marjorie F. Bates, Poughkeepsie, N. Y.
John H. Darrow, Poughkeepsie, N. Y.
- Pratt & Whitney Co.:
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T. P. Hollister, Rochester, N. Y.
- Price's Dairy Co.:
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Robert E. Price, El Paso, Tex.
- Princeton Board of Health:
William C. Beake, Princeton, N. J.
- Producers' Dairy Co.:
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M. J. McNamara, Brockton, Mass.
- Public Health Service, United States Department of the Treasury, Bureau of the:
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L. C. Frank, Washington, D. C.
Atherton Seidell, Washington, D. C.
- Purdue University:
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L. H. Fairchild, Lafayette, Ind.
H. W. Gregory, West Lafayette, Ind.
R. L. Hammond, Lafayette, Ind.
H. R. Rosenburg, West Lafayette, Ind.
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C. O. Tuttle, Lafayette, Ind.
- Pure Milk Dairy:
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- Reading, City of:
E. E. Romberger, Reading, Pa.
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- Red Rock Dairy:
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- Refrigeration Machinery Manufacturers' Association:
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John E. Ladd, Kingston, R. I.
A. E. Stene, Kingston, R. I.
- Rhode Island State Health Department:
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- Richmond Bureau of Health:
T. J. Strauch, Richmond, Va.
- Richmond Chamber of Commerce:
W. L. Kirby, Richmond, Va.
- Richmond Dairy Co.:
J. O. Scott, Richmond, Va.
- Rieck-McJunkin Dairy Co.:
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H. J. Bailey, State College, Pa.
James G. Lewis, Pittsburgh, Pa.
Mrs. James G. Lewis, Pittsburgh, Pa.
Carl E. Rieck, Pittsburgh, Pa.
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- Wm. H. Roberts and Sons (Inc.):
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- Roberts Sanitary Dairy Co.:
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J. R. Roberts, Omaha, Nebr.
- Rowe's Dairy:
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- Rural New Yorker:
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John J. Dillon, New York, N. Y.
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J. P. La Master, Clemson College, S. C.
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- South Carolina Guernsey Breeders' Association:
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C. W. Fitch, Montpelier, Vt.
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H. E. Bremer, Montpelier, Vt.
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Joseph L. Hills, Burlington, Vt.
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- Virginia Polytechnic Institute:
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- Virginia Jersey Cattle Club:
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- Western Pennsylvania Guernsey Breeders' Association:
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- Wisconsin College of Agriculture:
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